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TECHNICAL REPORT 2278

PENETRATION PERFORMANCE OF A SERIES OF T320E10 ARROW AP PROJECTILES (C)

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APRIL 1956

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PICATINNY ARSENAL
DOVER, N. J.

ORDNANCE PROJECT TA1-1475
DEPT. OF THE ARMY PROJECT 5A04-03-084

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Approved:

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for
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Director,
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Ammunition Laboratories

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OBJECT

To determine the penetration performance of a series of single and clustered T320E10 Arrow AP projectiles as a function of geometric scaling and sabot weight.

SUMMARY

Penetration performance has been determined for a series of Arrow projectiles geometrically scaled in two and three dimensions and having variable sabot weights. The calculations apply to ranges of 3,000 feet and 6,000 feet and are limited to clusters containing no more than four subprojectiles. A curve is presented extrapolating the Siacci Space Function,

$$S = -\int_{u}^{u_1} \frac{du_1}{G_2}$$

well beyond the range of tables known to be available at this time.

CONCLUSIONS

On the basis of Equations 6 (page 6) and 24 (page 9) it has been possible to calculate, for the conditions stated in this report, the thickness of armor defeated by certain geometrically scaled models of the T320E10 Arrow projectile.

The calculations indicate that:

a. For the 3-pound sabot now in use, the T320E10 Arrow is optimally designed (Fig 18, n = 1), but

b. For lighter sabots, the Arrow could be scaled down diameterwise to reach levels of penetration performance well beyond the present levels (for example, Fig 2, n = 1); and

c. The performance of the present single Arrow projectile could be equaled and indeed, surpassed, by clusters of suitably scaled projectiles using lighter sabots.

A broader interpretation of the results and conclusions of this report may be made by consulting the Discussion of Curves in conjuction with Figures 1 - 24.

SYMBOLS

B	Brinell Hardness Number, kg/mm^2
C_a, C_p	Ballistic coefficients corresponding to T320E10 Arrow and scaled projectiles respectively
d_a	Diameter of T320E10, single Arrow (sub-caliber), in.
d_g	Diameter of gun (full caliber), in.
d_p	Diameter of sub-projectile, in.
e	Thickness of armor defeated, in.
E_m	Muzzle energy = $W_t \dfrac{V_m^2}{2g}$, ft - lb
g	Gravitational constant, 32.2 ft/sec^2
i_a, i_p	Form factor of T320E10 Arrow and scaled projectiles, respectively
k_1, k_2	Constants
L	Length of gun, ft
n	Number of sub-projectiles in a cluster
R	Range, ft
S_m, S_s	Siacci number corresponding to V_m and V_s, respectively
V_m	Muzzle velocity, ft/sec
V_L	Ballistic Limit (= V_s), ft/sec
V_s	Striking velocity, ft/sec

W_p	Weight of sub-projectile, lb
W_a	Weight of T320E10 Arrow, lb
W_s	Weight of sabot, lb
W_t	Weight of sabot plus projectile, lb
x	Scale factor of sub-projectiles $(0 < x \leq 1)$
θ	Obliquity

CONDITIONS

$B = 260 \text{ kg/mm}^2$

$B_o = 500 - 160 \log_{10} \frac{xd_a}{1.565} \text{ kg/mm}^2$

$d_a = 40 \text{ mm} = 1.57 \text{ in.}$

$d_g = 90 \text{ mm} = 3.54 \text{ in.}$

$E_m = 3.61 \times 10^6 \text{ ft-lb}$

$L = 210 \text{ in.} = 17.5 \text{ ft}$

$R = 3000 \text{ ft and } 6000 \text{ ft}$

$V_m = 4600 \text{ ft/sec}$

$W_a = 8 \text{ lb}$

$$\left.\begin{array}{l} W_s = 3 \text{ lbs} \\ W_t = 11 \text{ lbs} \end{array}\right\} \text{corresponding to T320E10 Arrow}$$

$\theta = 45°$

INTRODUCTION

1. In a previous report (Ref A) the concept of an armor-piercing projectile cluster was studied under certain restricting assumptions. Besides questions involving the theory of probability, these restrictions included the use of a simplified formula for the calculation of armor penetration, and the assumption that velocity loss due to drag is negligible.

2. This report supplements the preliminary results of Reference A by using a more reliable and more widely applicable penetration formula, and by attempting to account for the effect of drag. The geometric scaling of projectiles has been extended to include two as well as three dimensions (See Assumptions and Definitions).

3. Attention is here focused on one particular armor-piercing projectile, the T320E10 Arrow. Since this type of projectile is used in combination with a standard sabot, the effect on penetration of decreasing the sabot's weight has been considered. It is hoped that this consideration may prove suggestive in connection with any proposed redesign of the projectile.

4. The present investigation differs from that of Reference A in that no attempt has been made to assess the hit probabilities corresponding to the clusters studied. Such considerations, while relevant to the final determination of optimum clusters, would form a separate study in themselves. Therefore, the comparisons of cluster performance presented in this paper are not intended as a final means of evaluating clusters. They show that one cluster is preferable to another (or to some single projectile) only to the extent that it is capable of defeating armor of greater thickness.

5. Finally, (Fig 18, n = 1) this report verifies the fact that the T320E10 Arrow-sabot system ($W_a = 8$ pounds, $W_s = 3$ pounds) is optimally designed. It is believed that this result independently corroborates the reliability of the method used in this paper to determine armor penetration.

ASSUMPTIONS AND DEFINITIONS

6. This report makes the fundamental assumption that muzzle energy is constant. A survey of relevant data suggests that, while this is never strictly true, it is not unreasonable to assume that the assumption holds

approximately. Muzzle energy has been computed from the mass of the T320E10 Arrow-sabot system and the muzzle velocity of the 90 mm gun used to fire it as follows:

$$E_m = \frac{W_t V_m^2}{2g} = \frac{11 \text{ lbs} \times (4600 \text{ ft/sec})^2}{64.4 \text{ ft/sec}^2}$$

$$= 3.61 \times 10^6 \text{ ft-lbs}$$

7. A secondary assumption is:

For the case of constant length scaling (that is, scaling in two dimensions) the choice of a constant ballistic coefficient results in conservative penetration estimates. The reliability of this assumption is demonstrated in paragraphs 15, 16, and 17.

8. The symbol "e", measured in inches, stands for that thickness of armor plate which can be "defeated" by a given projectile or each projectile in a cluster. The criterion for establishing defeat is that used by the United States Navy, which requires "that over 50% by weight of the impacting projectile pass completely through the armor." (Ref B, p. 3).

9. Geometric scaling of the T320E10 Arrow is used in the following two senses:

a. 2-Dimensional Scaling: refers to scaled reduction of the diameter of the Arrow projectile, the length remaining constant.

b. 3-Dimensional Scaling: refers to uniform scaled reduction of both the diameter and the length of the projectile.

DERIVATION OF PENETRATION FORMULAS FOR 3-DIMENSIONAL AND 2-DIMENSIONAL SCALING

10. The penetration formula developed by the National Physical Laboratory of Great Britain gives the following expression for the ballistic limit (the minimum striking velocity required to defeat armor of "e" thickness):

$$V_L = \frac{d_p^{3/2}}{W_p^{1/2}} \left[43.4\sqrt{B}\,\frac{e}{d_p}\,\sec\frac{3\theta}{2} + 929 - \frac{11800}{65-\theta} - \frac{54000}{B_o - B} \right] \quad (1)$$

11. The following equations will reformulate Equation (1) for 3-dimensional scaling:

$$W_p \propto d_p^3 \quad (2)$$

so that

$$W_p = k_1\, d_p^3 \quad (3)$$

where

$$k_1 = \frac{W_p}{d_p^3} = \frac{W_a}{d_a^3} = 2.05$$

In connection with Equation (1)

$$k_1^{1/2} = \frac{W_p^{1/2}}{d_p^{3/2}} = 1.43 \quad (4)$$

and

$$d_p = x d_a, \quad (5)$$

so that Equation (1) can be restated for 3-dimensional scaling as follows:

$$e = \left[0.00123V_L - 0.292 + \frac{46.5}{240 + 160\log_{10}\frac{0.994}{x}} \right] x \quad (6)$$

Before Equation 6 can be used, an expression for V_L is needed. Therefore, (from Equations 3 and 5:

$$W_p = k_1\, x^3\, d_a^3 \quad (7)$$

or

$$W_p = x^3 W_a \tag{8}$$

Now, for the T320E10 Arrow:

$$W_t = W_a + W_s \tag{9}$$

or, for "n" clustered sub-projectiles

$$W_t = n\, W_p + W_s \tag{10}$$

or

$$W_t = nx^3\, W_a + W_s, \tag{11}$$

Now since:

$$E_m = \frac{W_t V_m^2}{2g}, \tag{12}$$

it follows from Equation 9 that:

$$E_m = \frac{(n\,W_p + W_s)\, V_m^2}{2g}, \tag{13}$$

and from Equations 7 and 8:

$$E_m = \frac{n\,x^3\, W_a + W_s}{2g}\, V_m^2 \tag{14}$$

that is,

$$V_m = \sqrt{\frac{2g\,E_m}{n\,x^3\, W_a + W_s}} \tag{15}$$

where

$$E_m = 3.61 \times 10^6 \text{ ft-lbs} \tag{15a}$$

The problem now is to account for drag; that is, to determine the striking velocity, V_L, for a given V_M. From page 5 of Reference C, we obtain on simplification:

$$S_s = S_m + \frac{R}{C_p} \qquad (16)$$

where S is the tabulated integral, $S = -\int_{u}^{u_1} \frac{du_1}{G_2}$, said integral giving drag in terms of horizontal range for the particular function G_2. (Ref C, p. 4 and Ref D, pp. 3 - 4).

12. Now for every V_m computed from Equation 15, the integral S_m is determined (Ref F). And from Equation 16, S_s is determined. Finally, for every S_s, the table yields the corresponding V_s (or V_L); and Equation 6 can now be used to compute "e" as a function of V_L.

13. The expression for the ballistic coefficient, C_p, required by Equation 16 will now be derived. This derivation makes use of the fact that, for the single T320E10 Arrow, there is a velocity fall-off of about 250 ft/sec in 1000 yards. Taking V_m to be 4600 ft/sec, it follows (Ref C) that:

$$S_m = 2230 \text{ for } V_m = 4600$$

and,

$$S_s = 3650 \text{ for } V_s = 4350 \text{ (that is: 4600-250)}$$

Consequently, from Equation 16

$$C_a = \frac{R}{S_s - S_m} = \frac{3000}{1420} = 2.11 \qquad (17)$$

14. Now the ballistic coefficient is defined by the relation

$$C_p = \frac{W_p}{i_p d_p^2}, \qquad (18)$$

and, insofar as the form factor "i_p" is unchanged in 3-dimensional scaling, it follows that

$$C_p = \frac{W_p}{i_p d_p^2} = \frac{x^3 W_a}{i_a x^2 d_a^2} = xC_a \qquad (19)$$

Finally, from Equation (17):

$$C_p = 2.11x \tag{20}$$

In the case of 2-dimensional scaling,

$$W_p \propto d_p^2 \tag{21}$$

$$W_p = k_2 d_p^2 \tag{22}$$

where:

$$k_2 = \frac{W_p}{d_p^2} = \frac{W_a}{d_a^2} = 3.23$$

and

$$k_2^{1/2} = \frac{W_p^{1/2}}{d_p} = 1.80 \tag{23}$$

Thus Equation (1) is transformed for 2-dimensional scaling into:

$$e = 0.00123 V_L x^{1/2} - 0.292x + \frac{46.5x}{(240 + 160 \log_{10} \frac{0.994}{x})} \tag{24}$$

The calculation of V_L in Equation 24 is based on a procedure similar to that used in 3-dimensional scaling:
From Equations 22 and 5 it follows that:

$$W_p = k_2 x^2 d_a \tag{25}$$

or

$$W_p = x^2 W_a \tag{26}$$

and from Equation 10

$$W_t = nx^2 W_a + W_s, \tag{27}$$

so that

$$V_m = \sqrt{\frac{2g\,E_m}{mx^2 W_a + W_s}} \tag{28}$$

Finally, V_L is determined, as it was in the case of 3-dimensional scaling, from Equation 16. The only difference is that "C_p" is assumed constant, that is, $C_p = C_a = 2.11$.

15. It will now be shown that this assumption leads to conservative estimates of "e"

From Equations 18, 5, and 26 it follows that

$$C_p = \frac{W_p}{i_p d_p^2} = C_a = \frac{x^2 W_a}{i_a x^2 d_a^2} = 2.11, \tag{29}$$

that is, the assumption $C_p = C_a$ entails $i_p = i_a$ (because

$$\frac{W_p}{d_p^2} = \frac{W_a}{d_a^2} = k_2).$$

16. But the form factor "i" is (among other things) a measure of projectile slenderness; that is, for a fixed length, as in 2-dimensional scaling of the Arrow, low "i" corresponds to a relatively slender projectile and high "i" to a relatively thick projectile.

Actually, then in Equation (29) $i_p \neq i_a$.

Rather

$$i_p < i_a \tag{30}$$

This would mean that $C_p \neq C_a$, that is $C_p > C_a$ (31)

17. In connection with Equation 31, increasing "C", by definition, corresponds to a reduction in drag. The inequality expressed by Equation 31, therefore, indicates that Assumption 29 exaggerates the effect of drag on 2-dimensionally scaled models of the T320E10 Arrow, so that the corresponding "e" estimates made on that assumption are conservative.

DISCUSSION OF CURVES

18. Figures 1 - 24 give thickness of armor defeated "e" as a function of scale factor "x" and projectile weight "W_p". Each figure corresponds to a different sabot weight "W_s" and includes, in addition to the case of the single projectile (n = 1), clusters with up to four sub-projectiles (n = 2, 3, 4).

Figures 1 - 24 are divided into four groups as follows:

a. Figures 1 - 6 apply to a 2-dimensional scaling for a range "R" of 3,000 feet
b. Figures 7 - 12 apply to 2-dimensional scaling, R = 6000 feet
c. Figures 13 - 18 apply to 3-dimensional scaling, R = 3000 feet
d. Figures 19 - 24 apply to 3-dimensional scaling, R = 6000 feet

19. For comparative purposes Figures 1 - 6 should be studied against Figures 13 - 18, and Figures 7 - 12 against Figures 19 - 24. This amounts to comparing the relative merits of two types of scaling for the two ranges considered. These comparisons show that, although both types of scaling result in improved penetration performance of the T320E10 Arrow, 2-dimensional scaling is preferable to 3-dimensional scaling.

20. As a precaution, "e" has been plotted against "W_p" as well as against "x" since the assumption of constant muzzle energy becomes less reliable as "W_p" gets very small. (This does not mean that the assumption breaks down altogether, or that the precise value of "W_p" at which this happens is known). Therefore, portions of the penetration curves corresponding to very low "W_p" must be interpreted with care.

21. To illustrate the use of these curves, consider Figures 2 and 18. Observe that for the (unscaled) Arrow used in combination with a sabot weighing 3 pounds (Fig 18), "e" is about 5.2 inches. Now, consider the possibility of lowering the weight of "W_s" from 3 pounds to one pound, and scaling down the diameter of the Arrow to, for example, 0.6 of its present size. For these conditions, Figure 2 shows an "e" equal to about 7.1 inches, which would amount to improving penetration performance of the T320E10 by about 36%. (This is a conservative estimate since the "e" figures for 2 dimensional scaling have been understated (par 7).

22. Also, Figure 2 suggests (n = 3, x = 0.3) that it is possible to at least equal the penetration performance of the single T320E10 Arrow (Fig 18, n = 1, x = 1) with a cluster containing three sub-projectiles, in the sense that each sub-projectile would have an "e" of about 5.5 inches. Further comparisons of Figures 1 - 24 lead to similar conclusions for other values of "x", "W_s" and "R".

23. Finally, Figure 25 gives the Siacci Space Integral, "S", (for the drag function "G_2") as a function of projectile velocity, "V". The use of "S" numbers is briefly illustrated in paragraphs 11 and 12 but, in practice (if graphical methods are used), a much finer plot than Figure 25 is required.

ACKNOWLEDGEMENT

Appreciation is expressed to Bert Karin and Herbert Cohen; the former for his practical suggestions, the latter for his preliminary work (Ref A) which suggested the direction of the present report.

REFERENCES

A. Cohen, Herbert N., *Analysis of Clustered AP Projectiles for Antitank Use,* Picatinny Arsenal, ERS Technical Memo 7, Feb 1955

B. PROJECT THOR: *A Suggested Technique for Predicting the Performance of Armor-Piercing Projectiles Acting on Rolled Homogeneous Armor,* Technical Report 14, The Johns Hopkins University, Baltimore, Md., 1954.

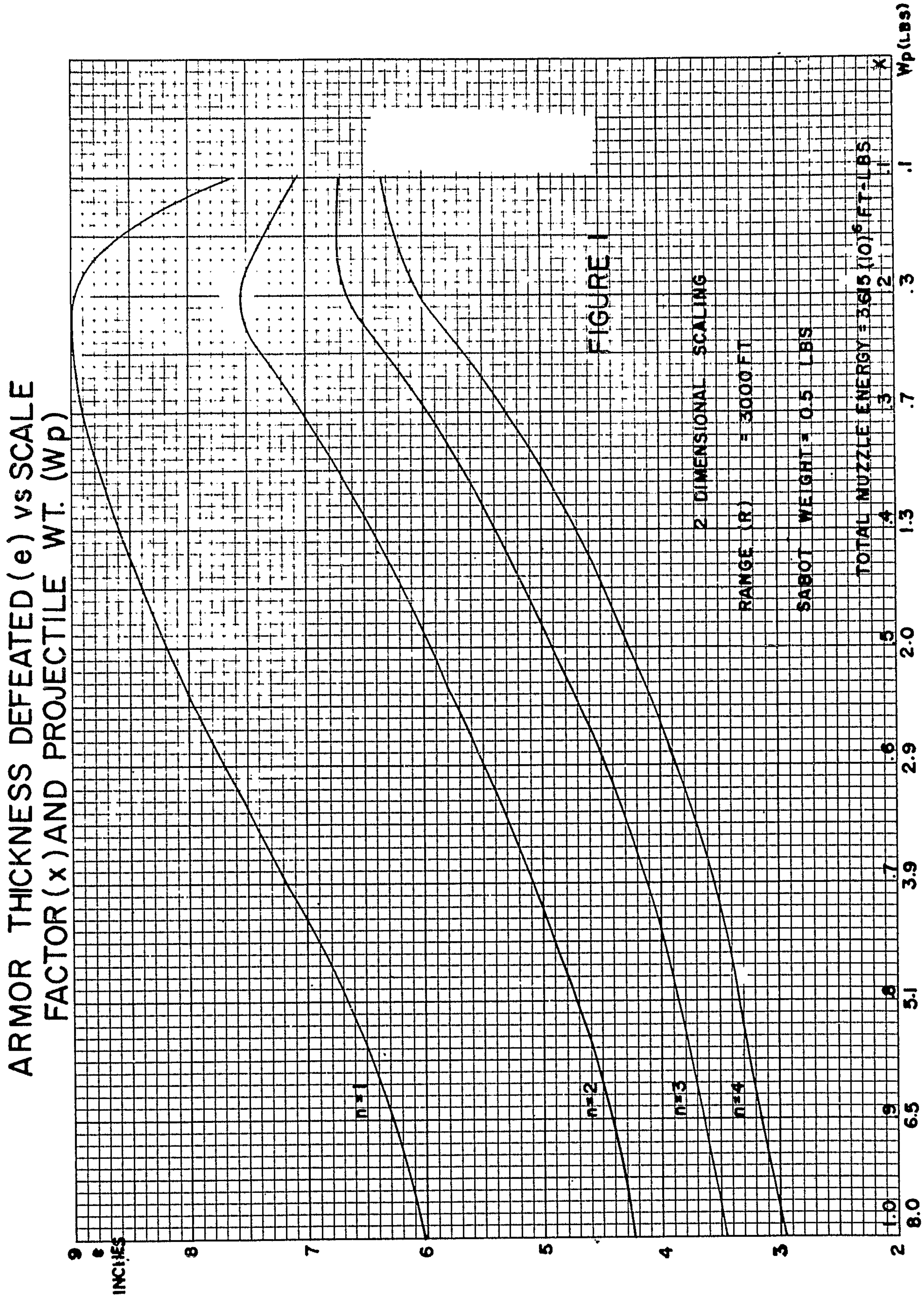
C. Hitchcock, H. P., *Applications of Siacci's Method to Flat Trajectories,* Ballistics Research Laboratory Technical Report 118, Aberdeen Proving Ground, 1938

D. Hitchcock, H. P., *Form Factors of Projectiles,* Ballistics Research Laboratory Technical Report 284, Aberdeen Proving Ground, 24 June 1942

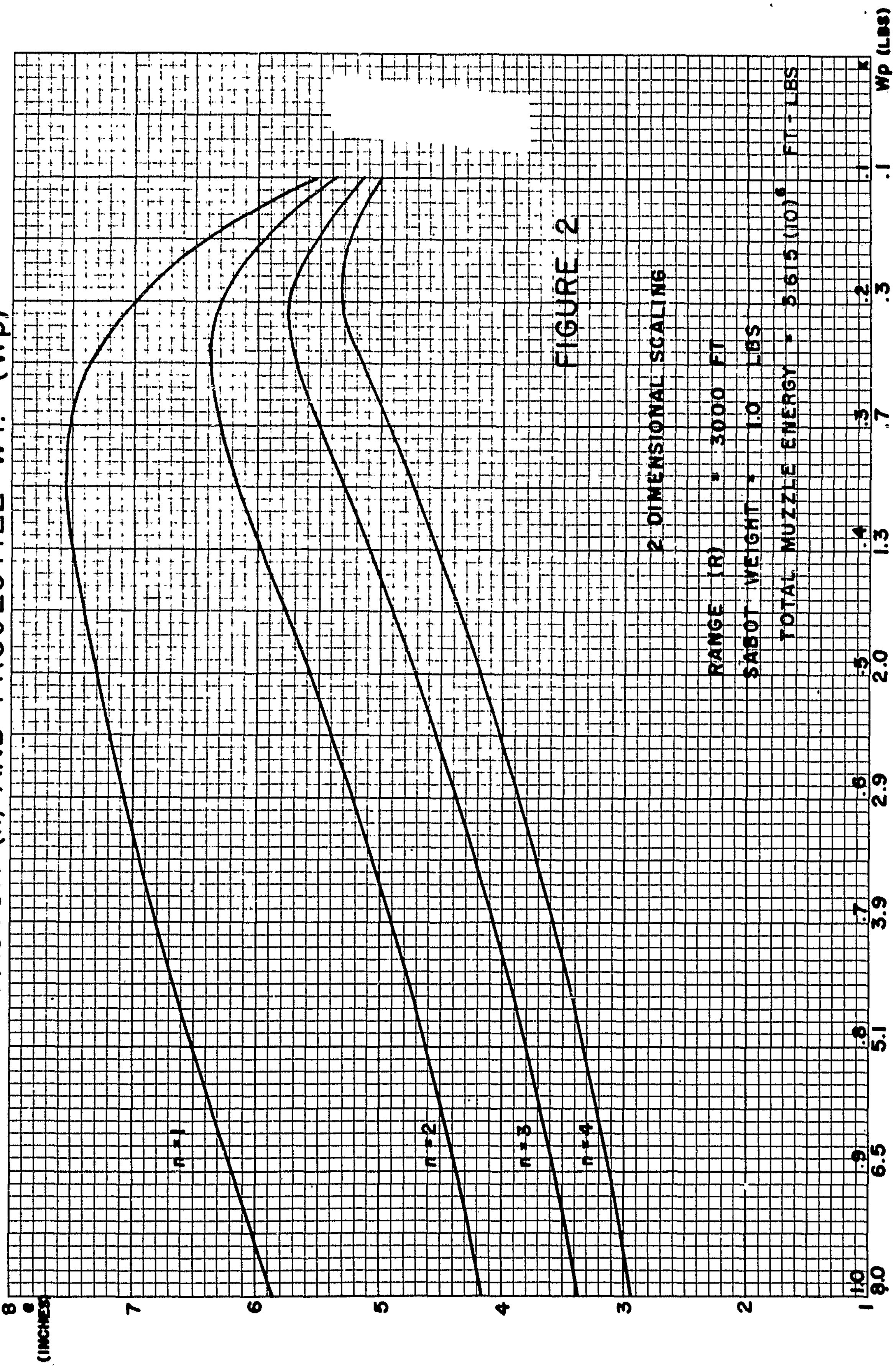
E. Curtiss, C. F., et al., *Interior Ballistics,* Office Scientific Research and Development Report 6468

F. Iannotti, C. R., *90 MM, Fin Stabilized, Armor Piercing Shot, Sabot Discarding,* Frankford Arsenal Technical Report 1184 and Addendum, 1954

G. *Tables of Space and Time Based on the Standard Drag Functions,* Ballistics Research Laboratory, Aberdeen Proving Ground, (circa 1943)


ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)
FIGURE I
2 DIMENSIONAL SCALING
RANGE (R) = 3000 FT
SABOT WEIGHT = 0.5 LBS
TOTAL MUZZLE ENERGY = 3.615 (10)^6 FT-LBS
n=1
n=2
n=3
n=4
INCHES
e
9
8
7
6
5
4
3
2
X
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
Wp (LBS)
8.0
6.5
5.1
3.9
2.9
2.0
1.3
.7
.3
.1

ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)



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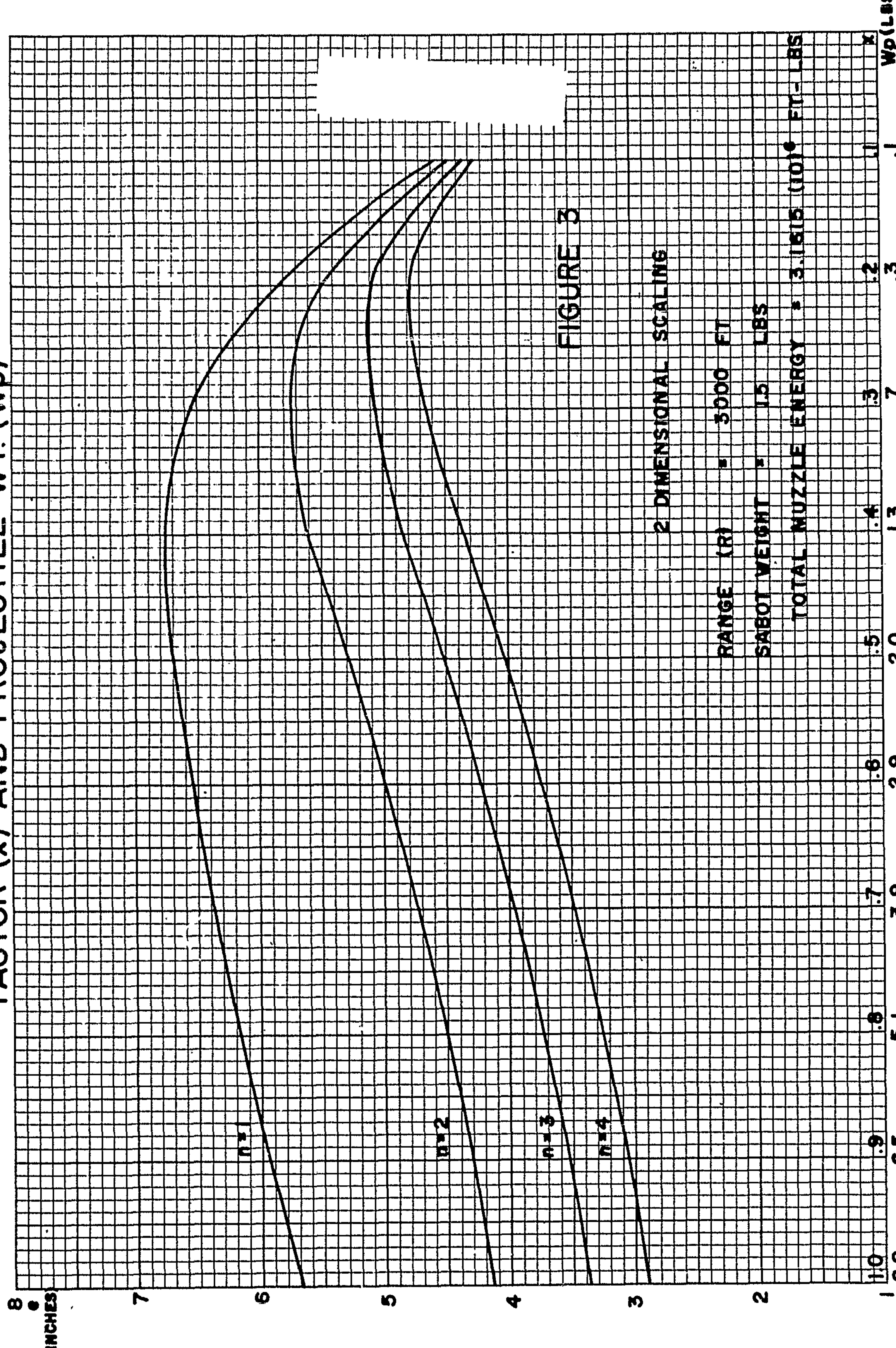

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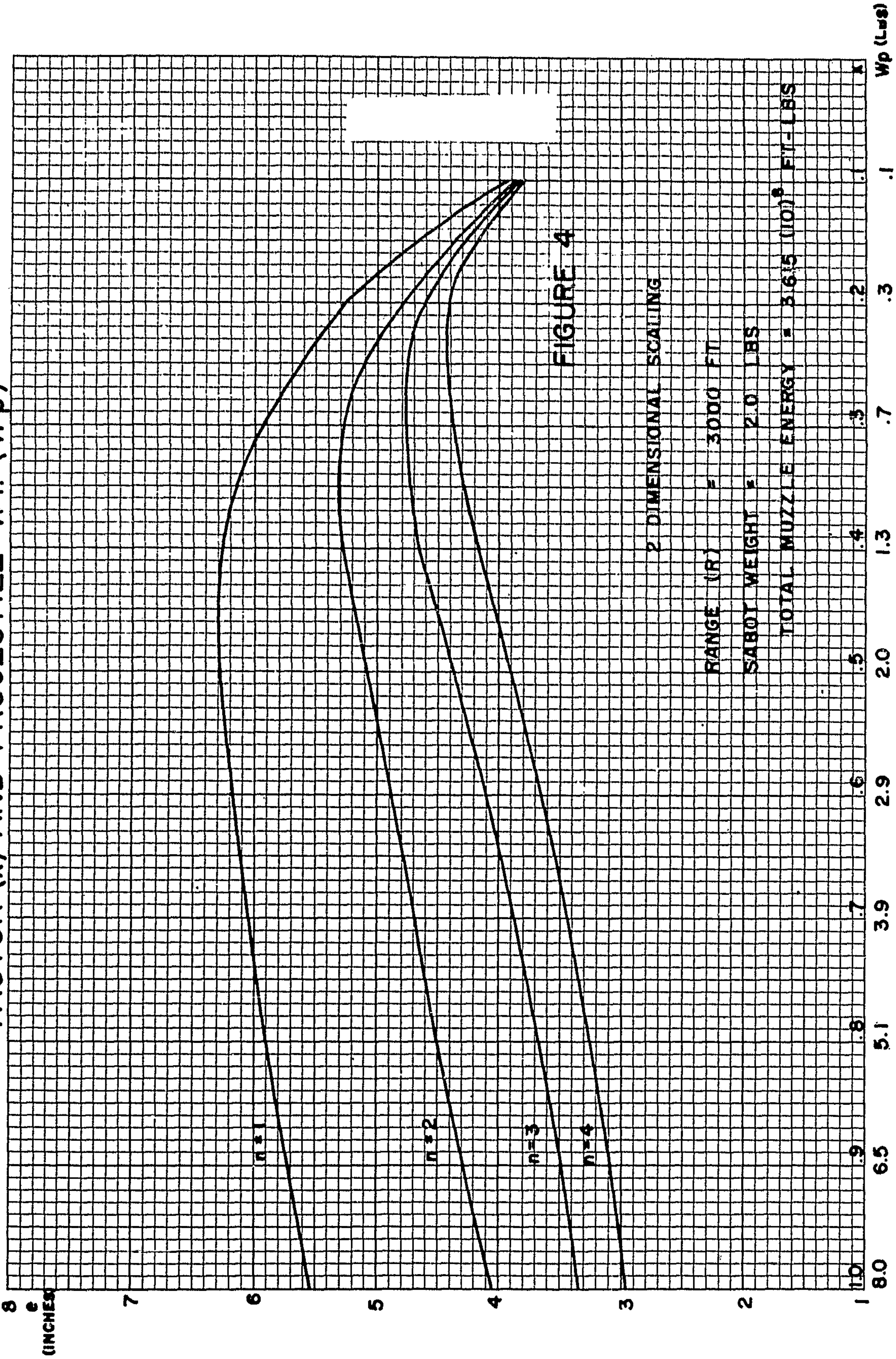
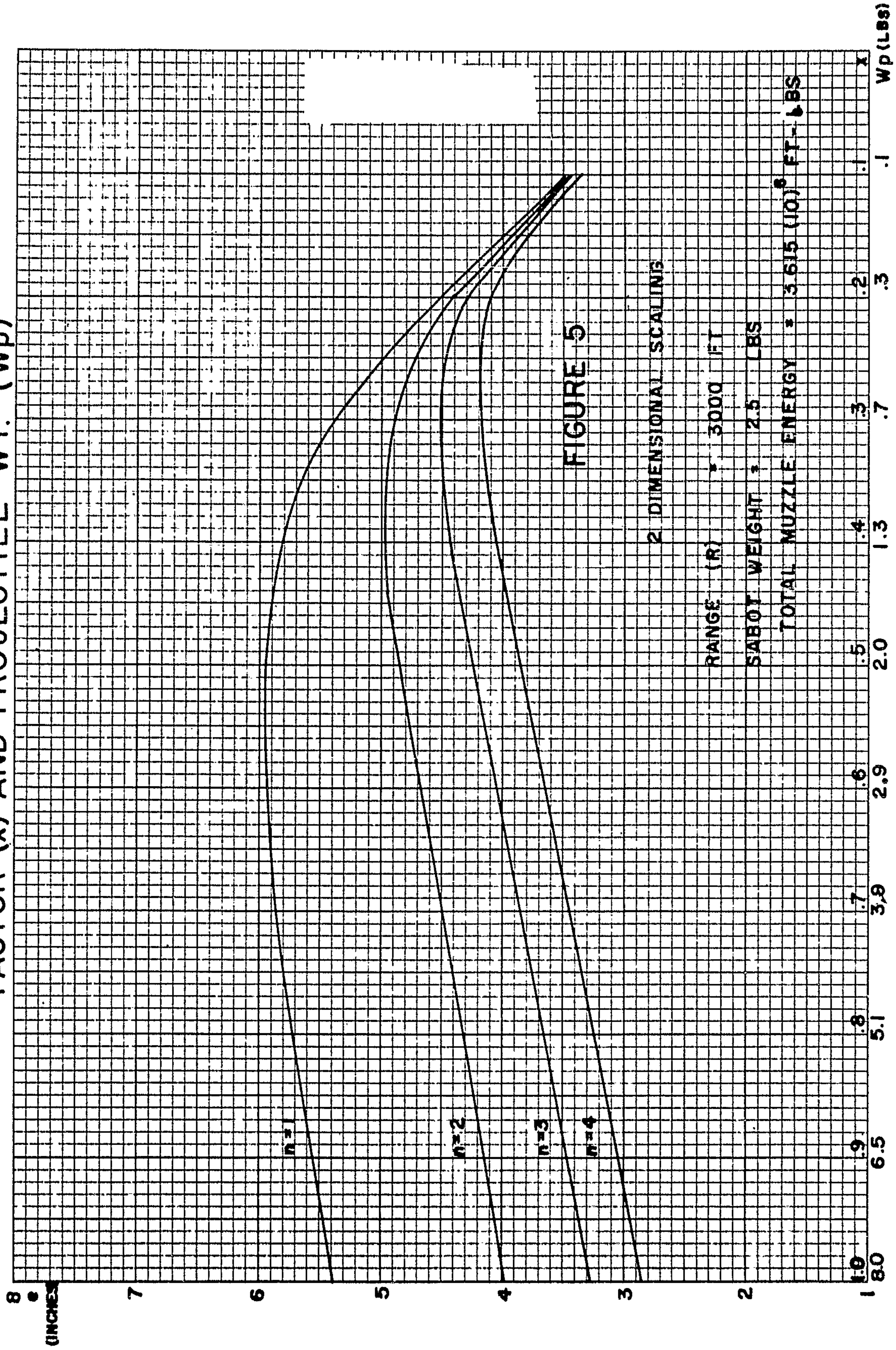
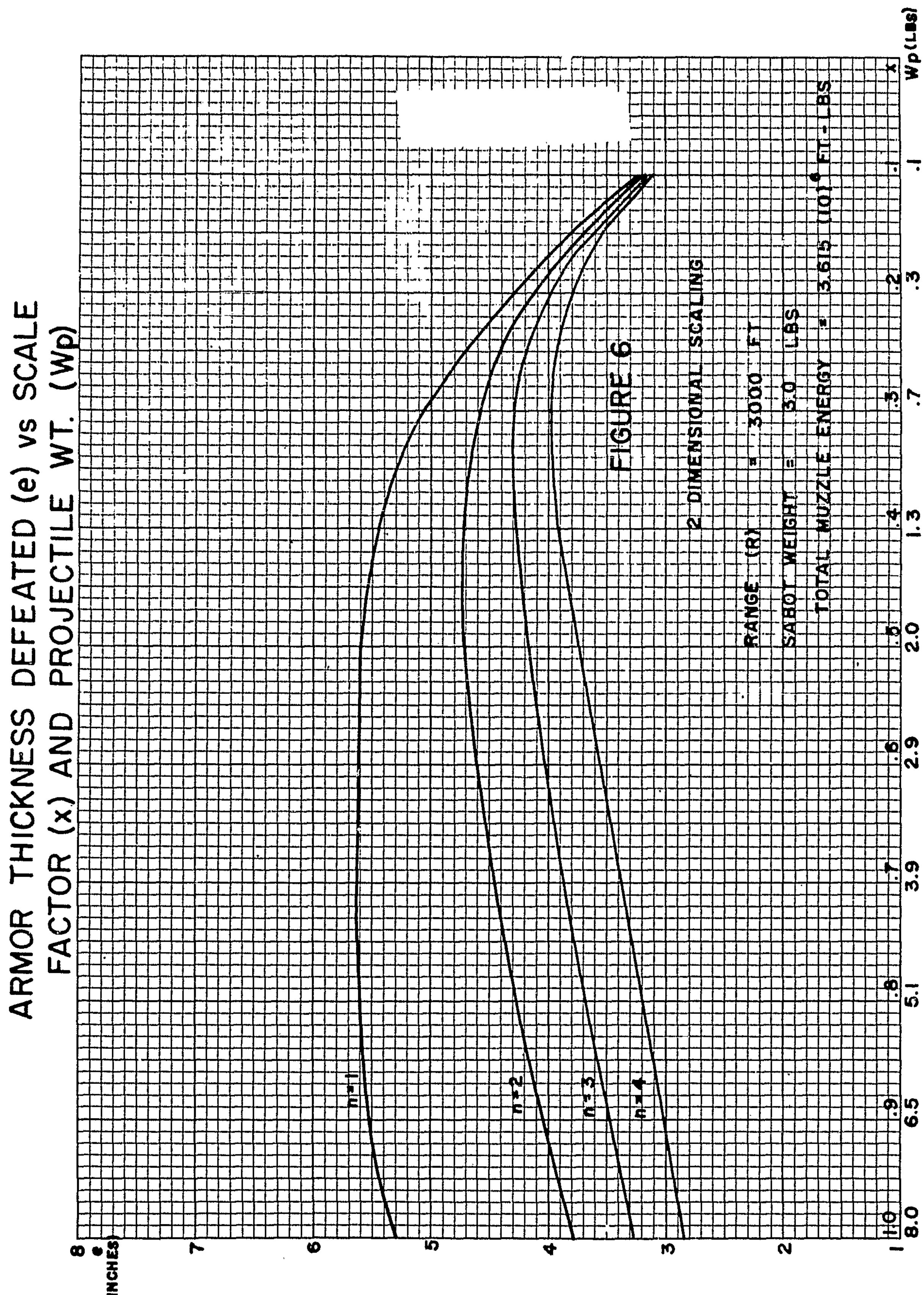
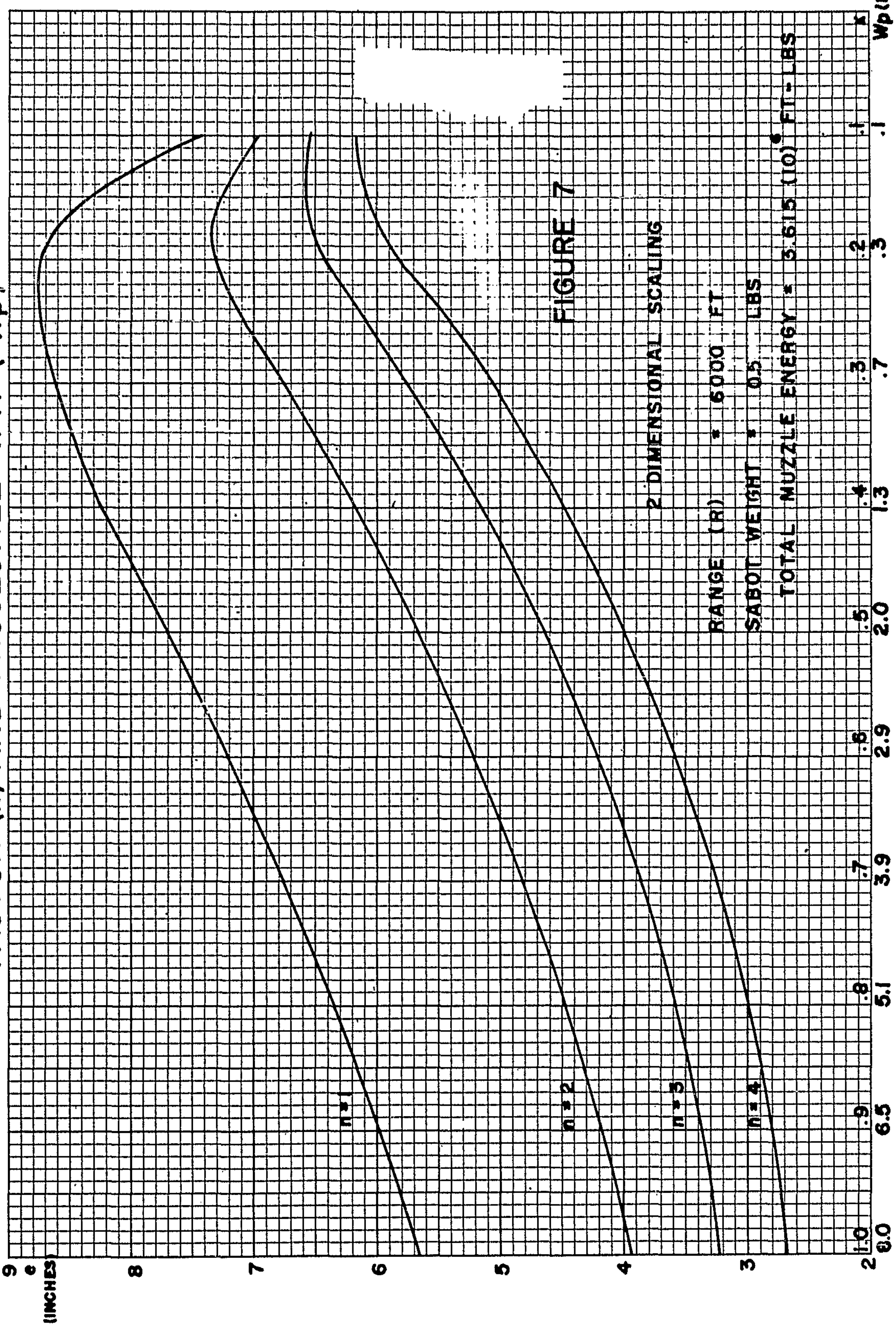


ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

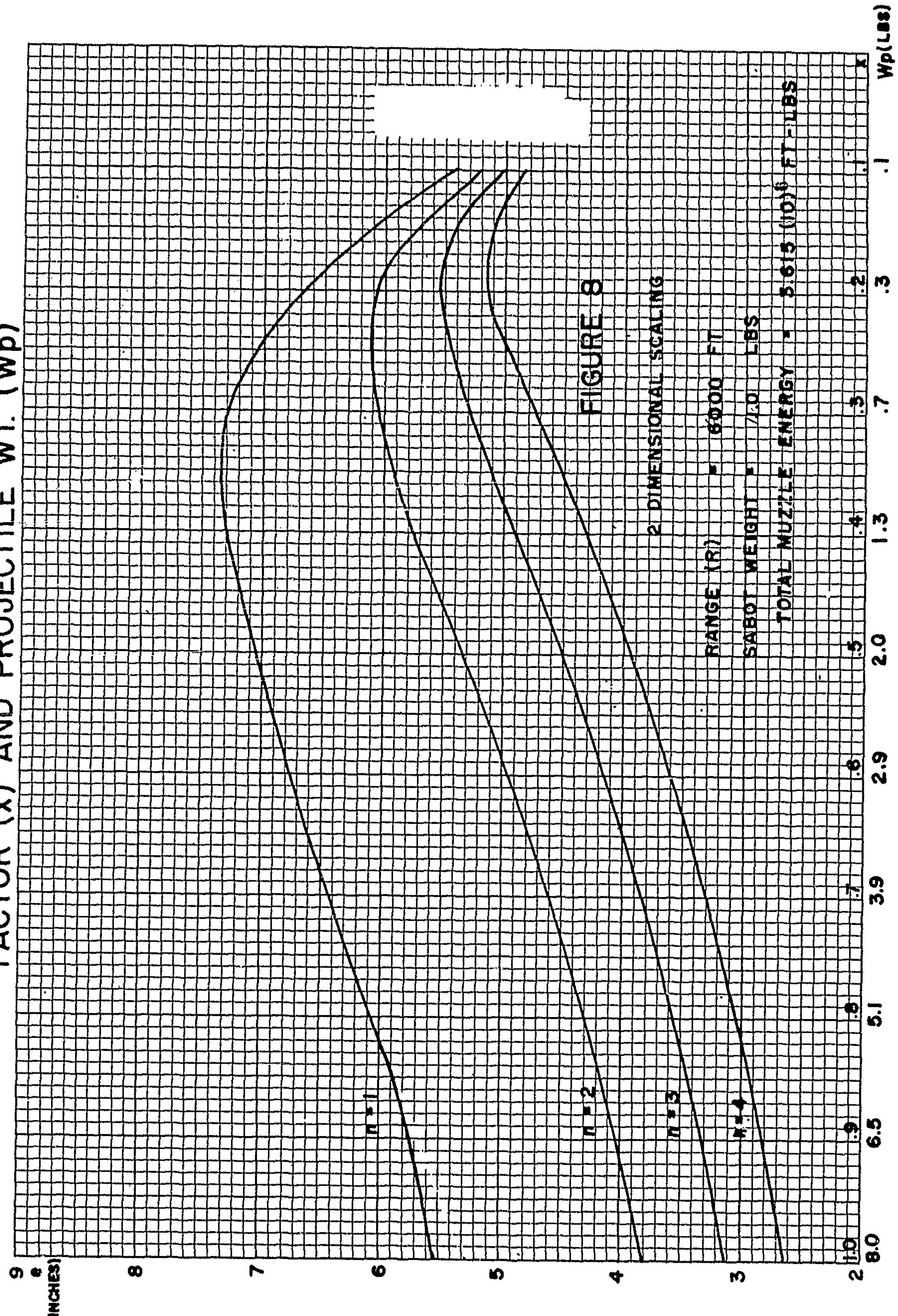



ARMOR THICKNESS DEFEATED (e) vs SCALE
FACTOR (x) AND PROJECTILE WT. (Wp)
FIGURE 6
2 DIMENSIONAL SCALING
RANGE (R) = 3000 FT
SABOT WEIGHT = 3.0 LBS
TOTAL MUZZLE ENERGY = 3.615 (10)^6 FT - LBS
n=1
n=2
n=3
n=4
e (INCHES)
8
7
6
5
4
3
2
1
x
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
Wp (LBS)
.3
.7
1.3
2.0
2.9
3.9
5.1
6.5
8.0



ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)



ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

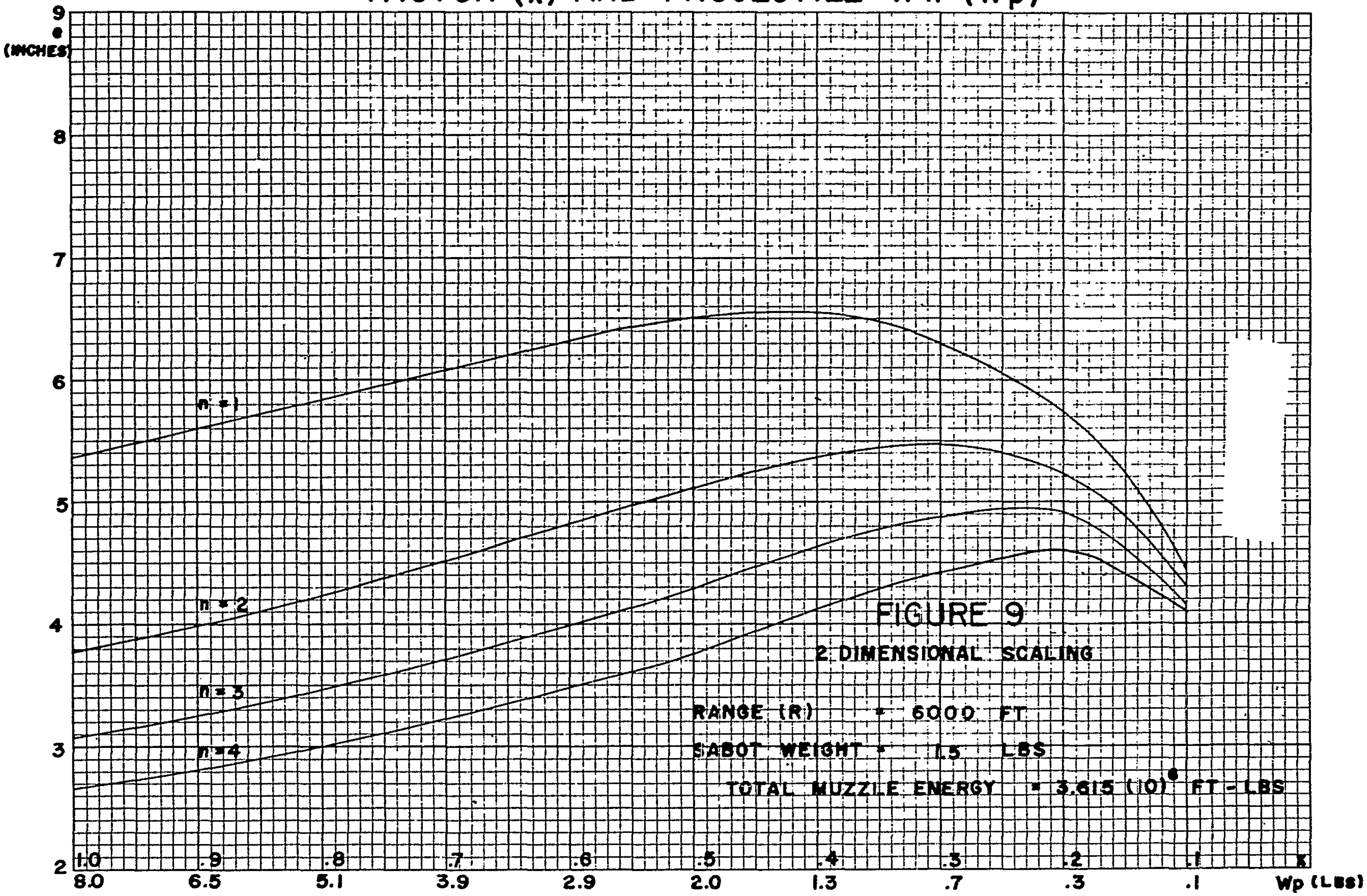


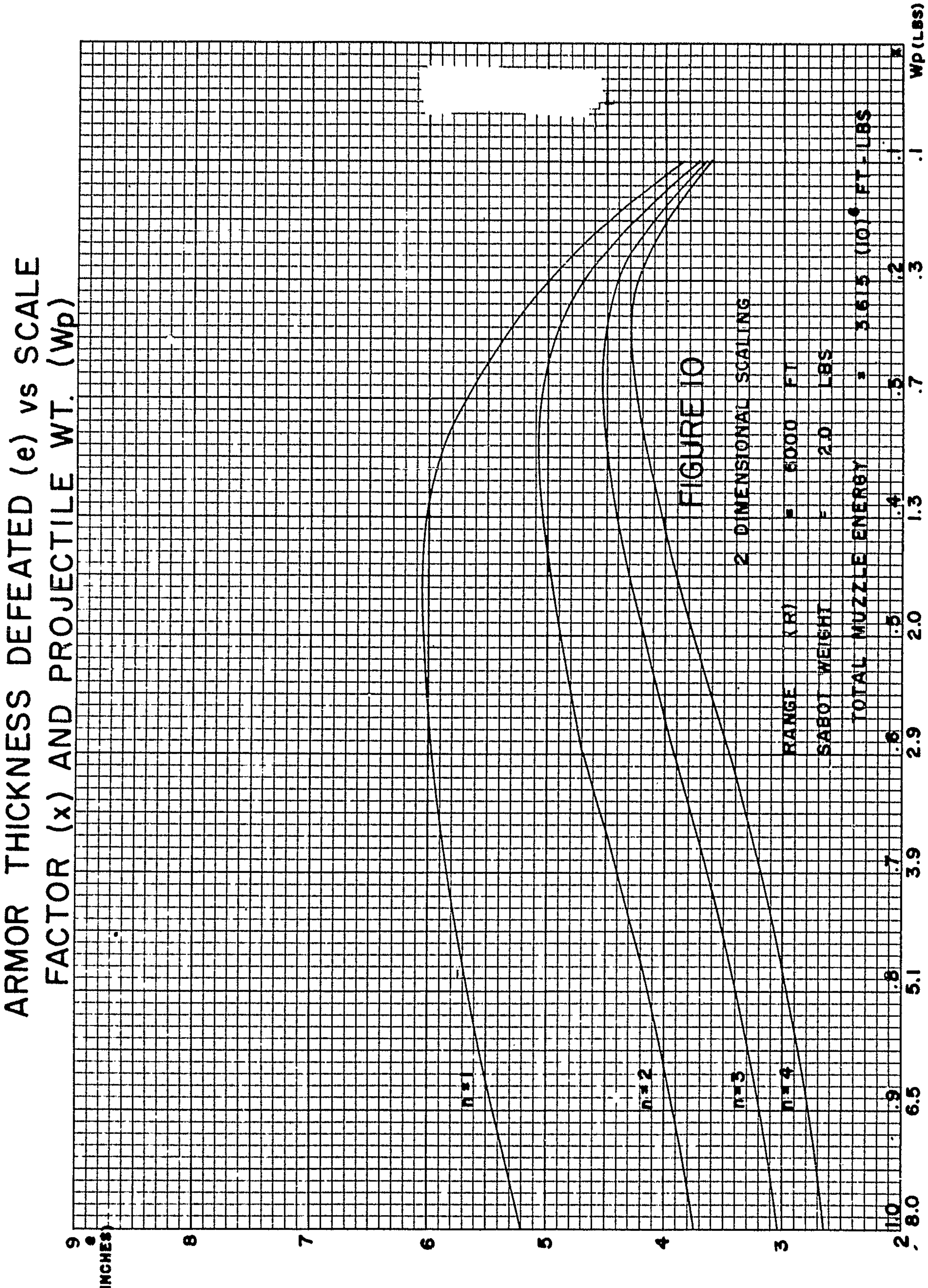
FIGURE 9

2 DIMENSIONAL SCALING

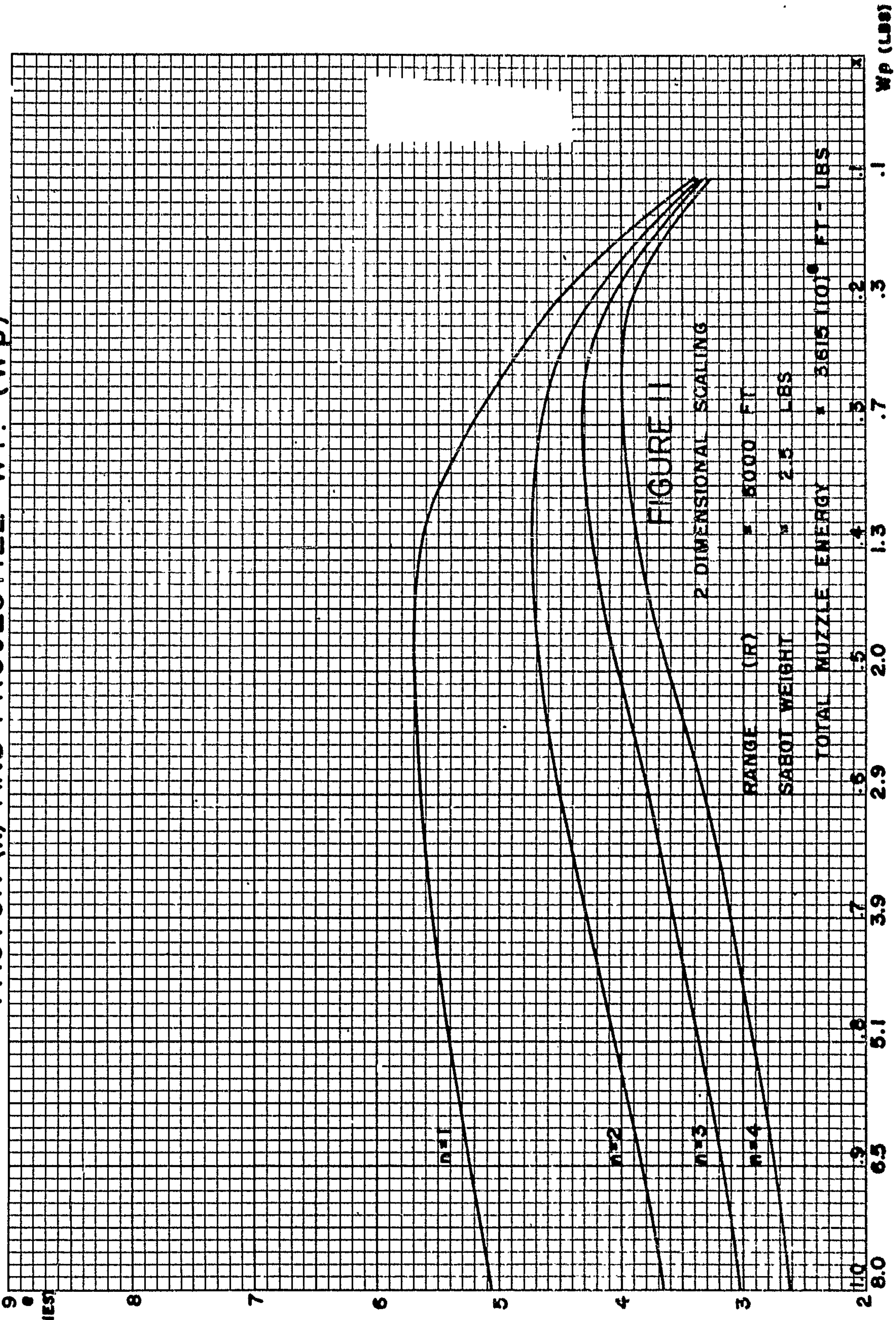
RANGE (R) = 6000 FT

SABOT WEIGHT = 1.5 LBS

TOTAL MUZZLE ENERGY = 3.615 (10)^6 FT-LBS


ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)
FIGURE 10
2 DIMENSIONAL SCALING
RANGE (R) = 6000 FT
SABOT WEIGHT = 2.0 LBS
TOTAL MUZZLE ENERGY = 3.65 (10)^6 FT-LBS
n=1
n=2
n=3
n=4
e (INCHES)
Wp (LBS)
x

ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)



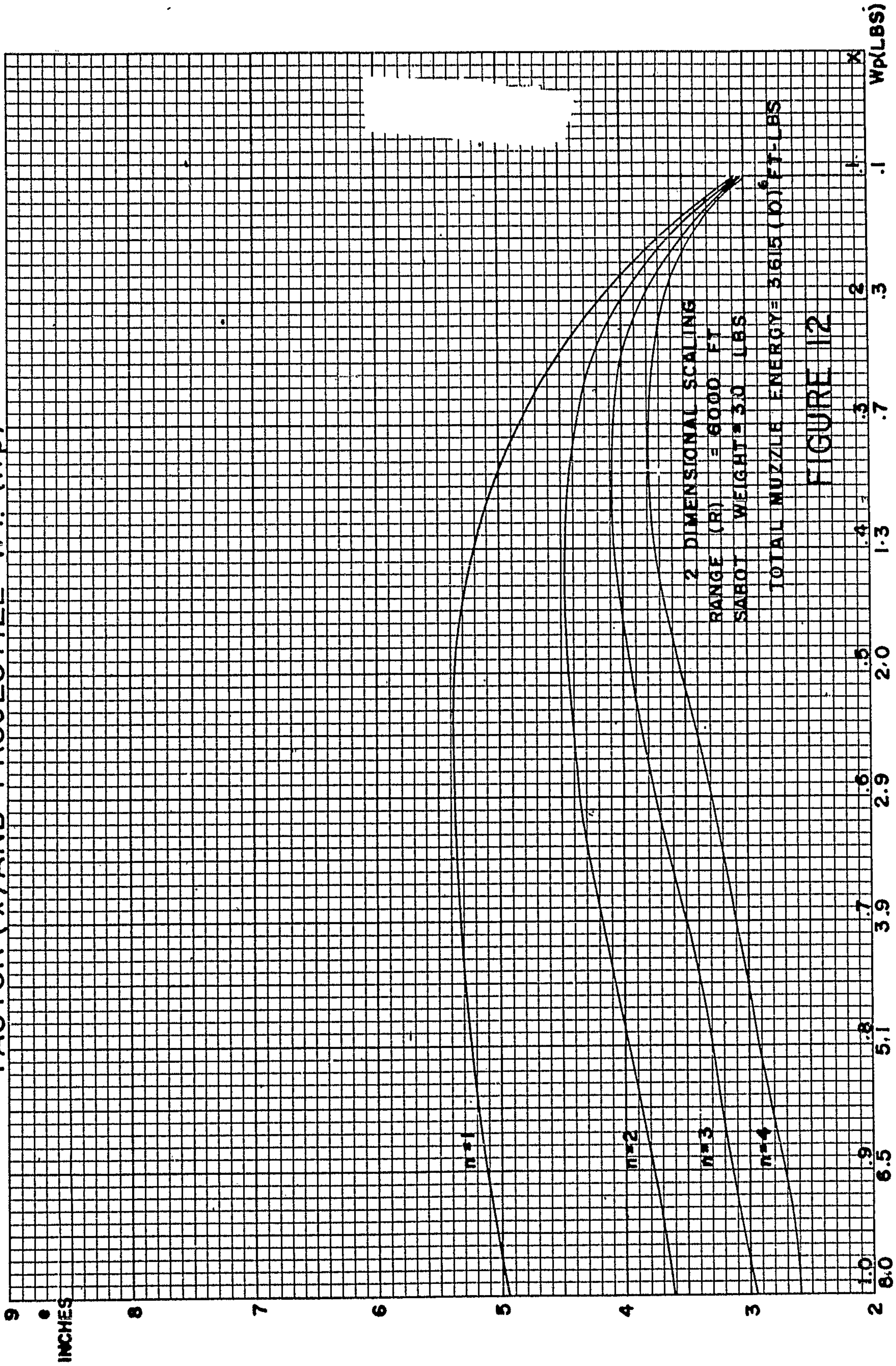
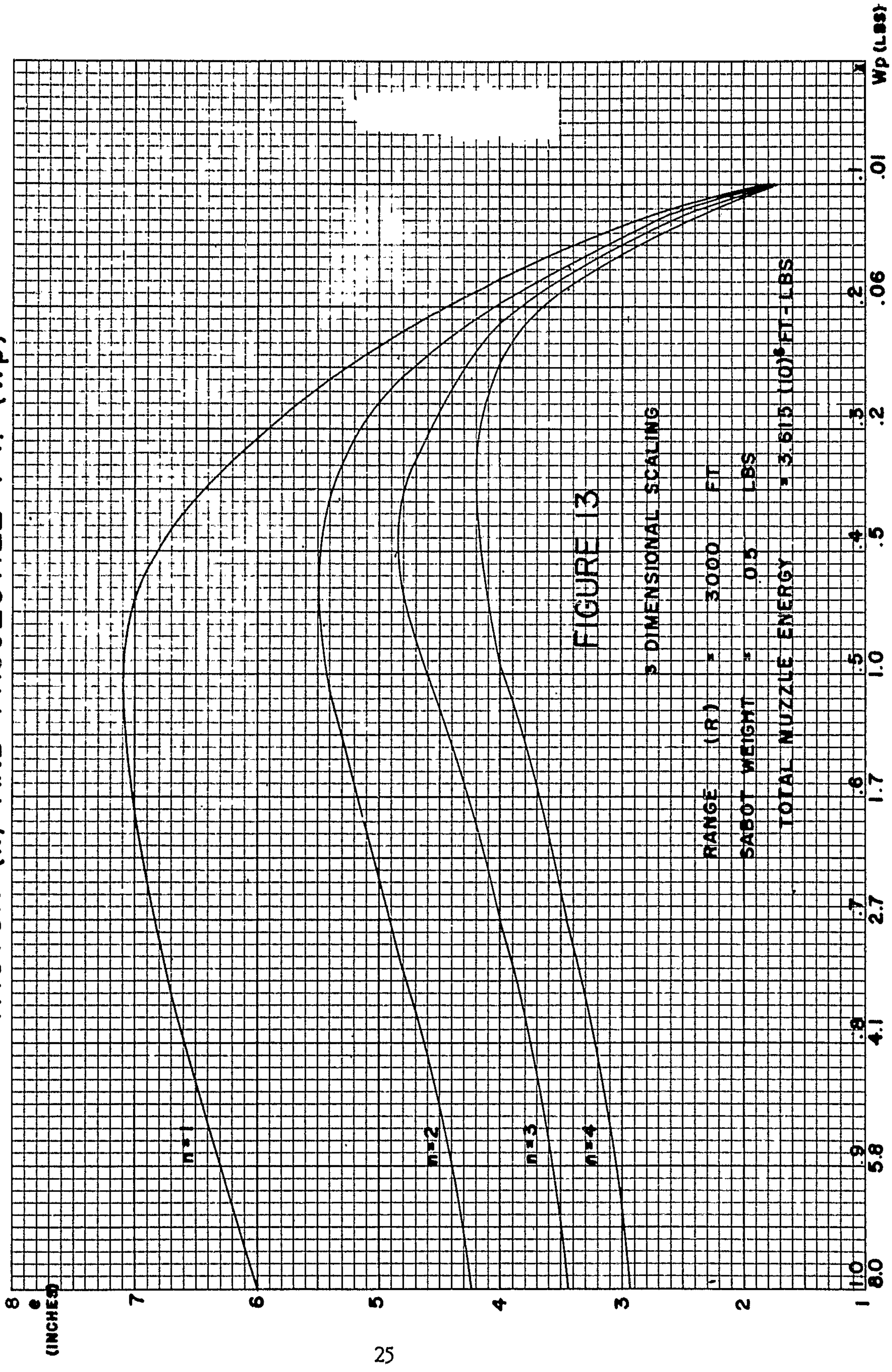


FIGURE 12

ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)



ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

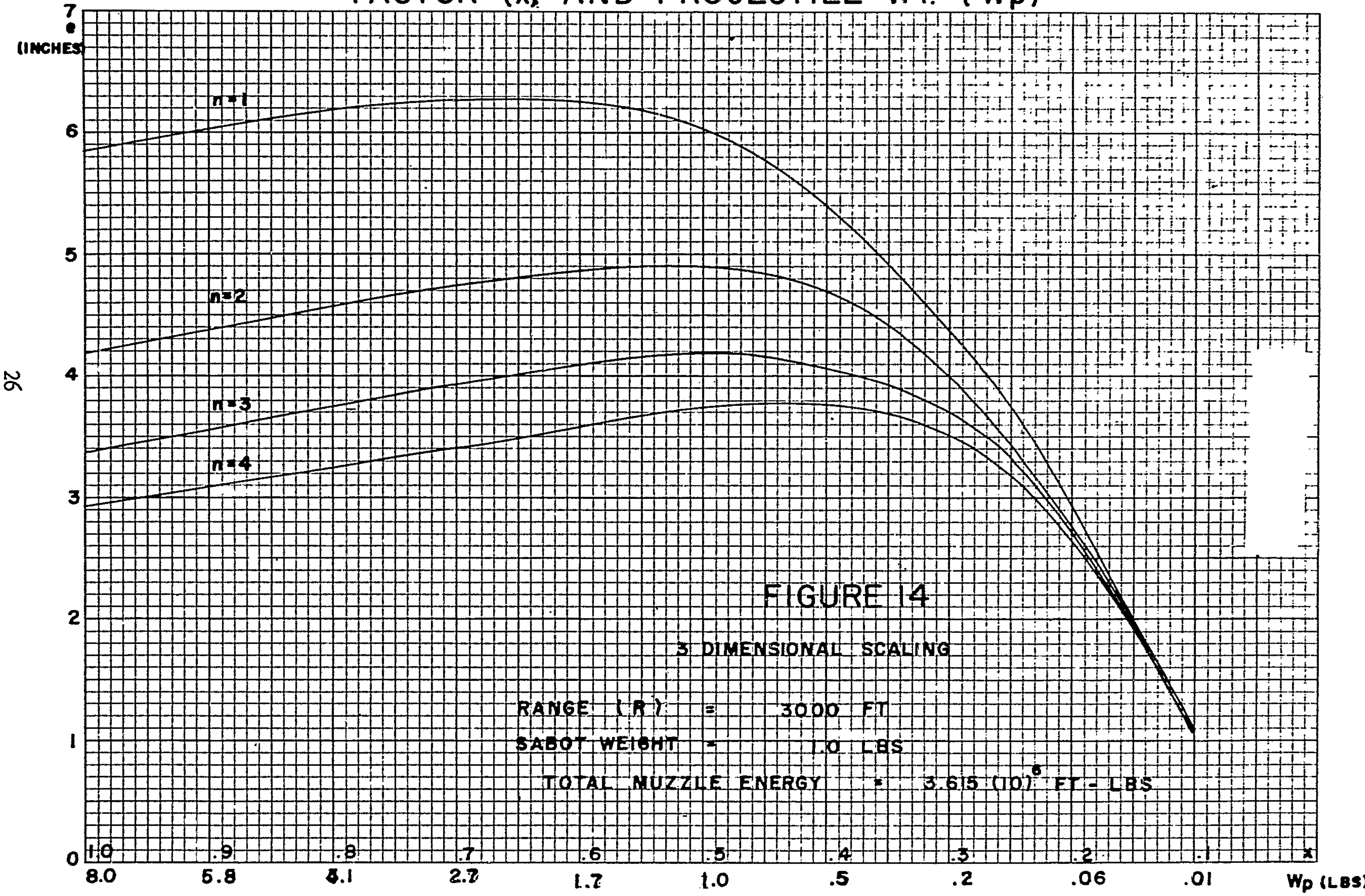


FIGURE 14

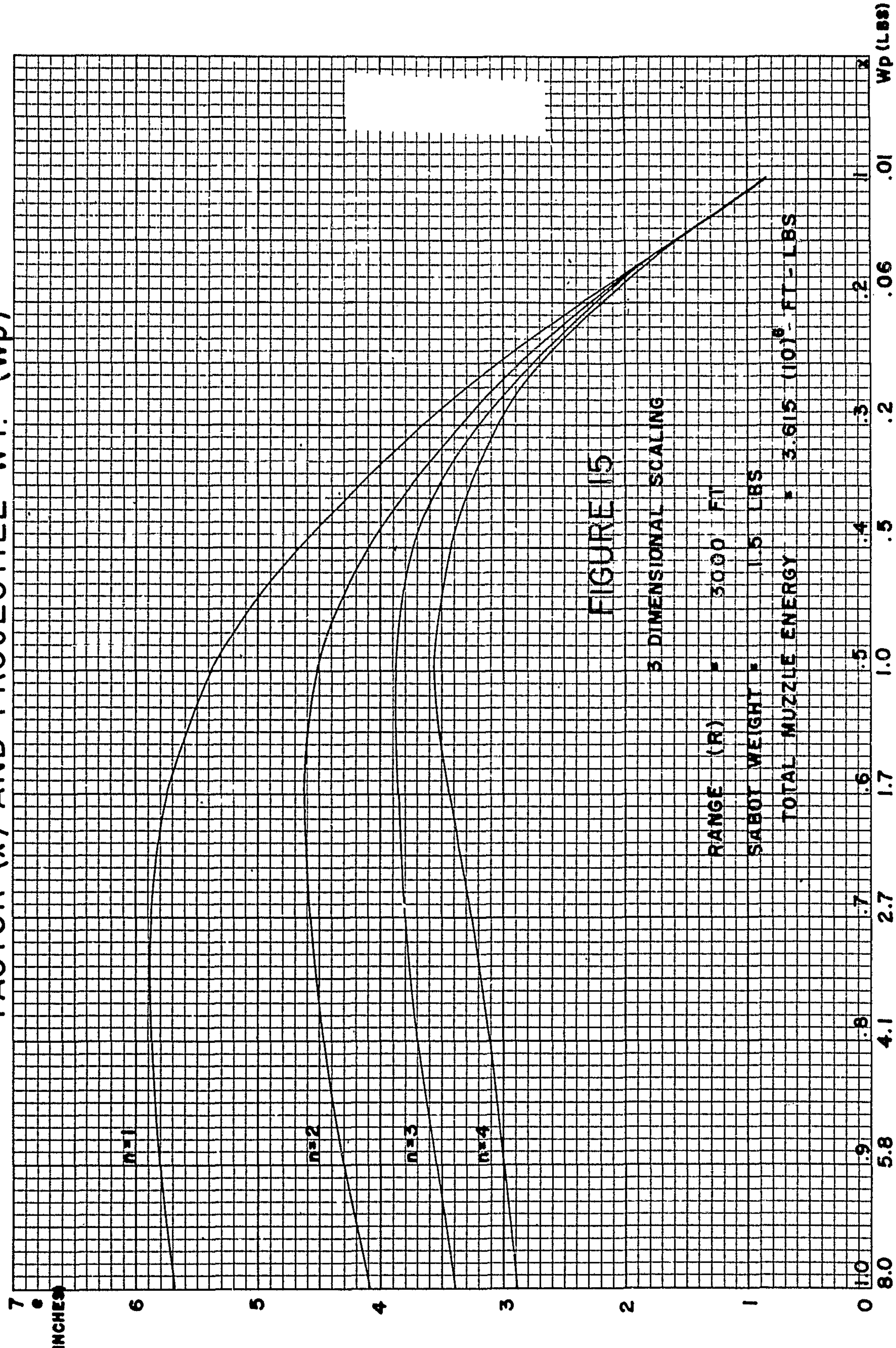
3 DIMENSIONAL SCALING

RANGE (R) = 3000 FT

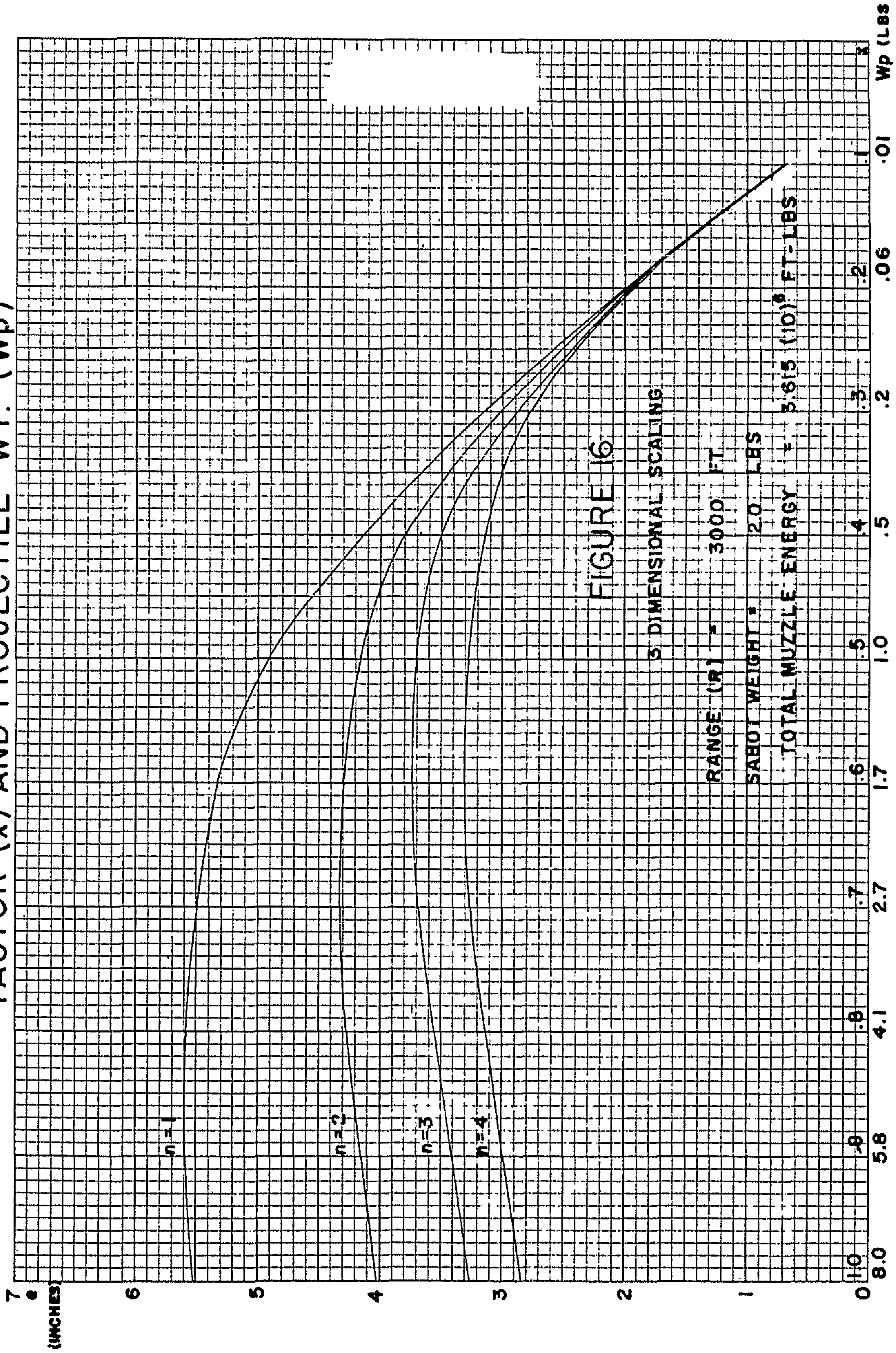
SABOT WEIGHT = 1.0 LBS

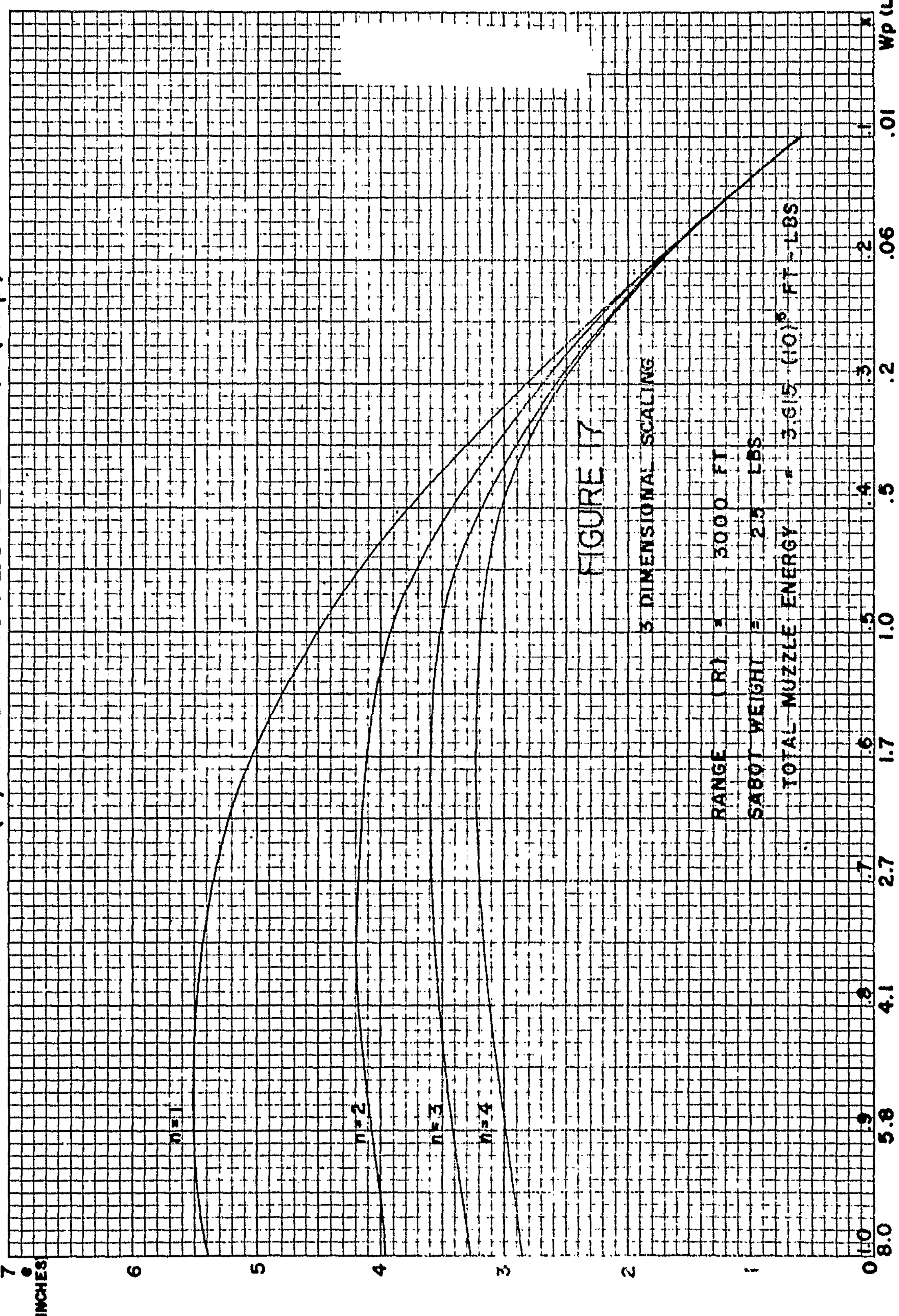
TOTAL MUZZLE ENERGY = 3.615 (10)^6 FT - LBS

ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)



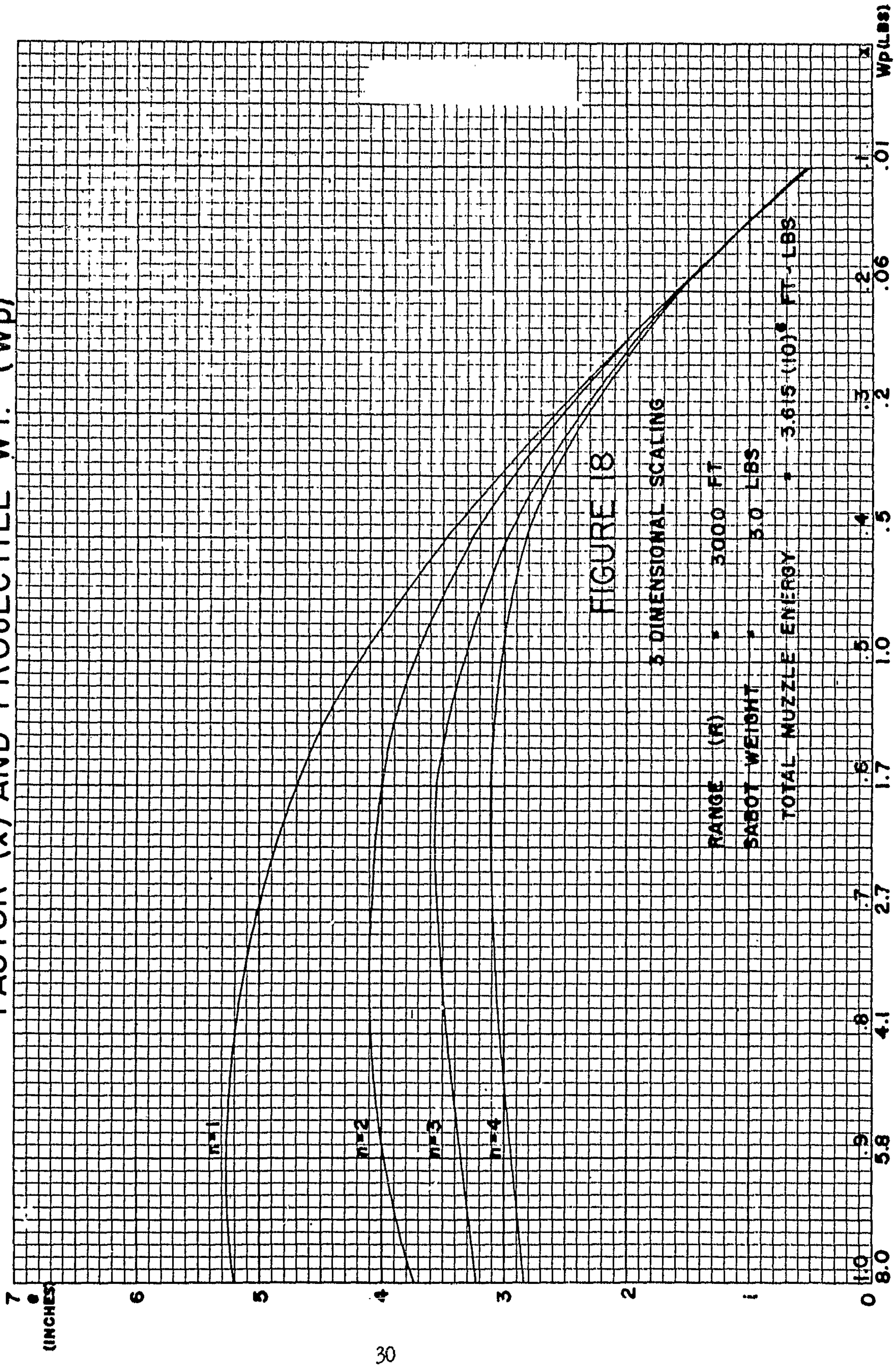
ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

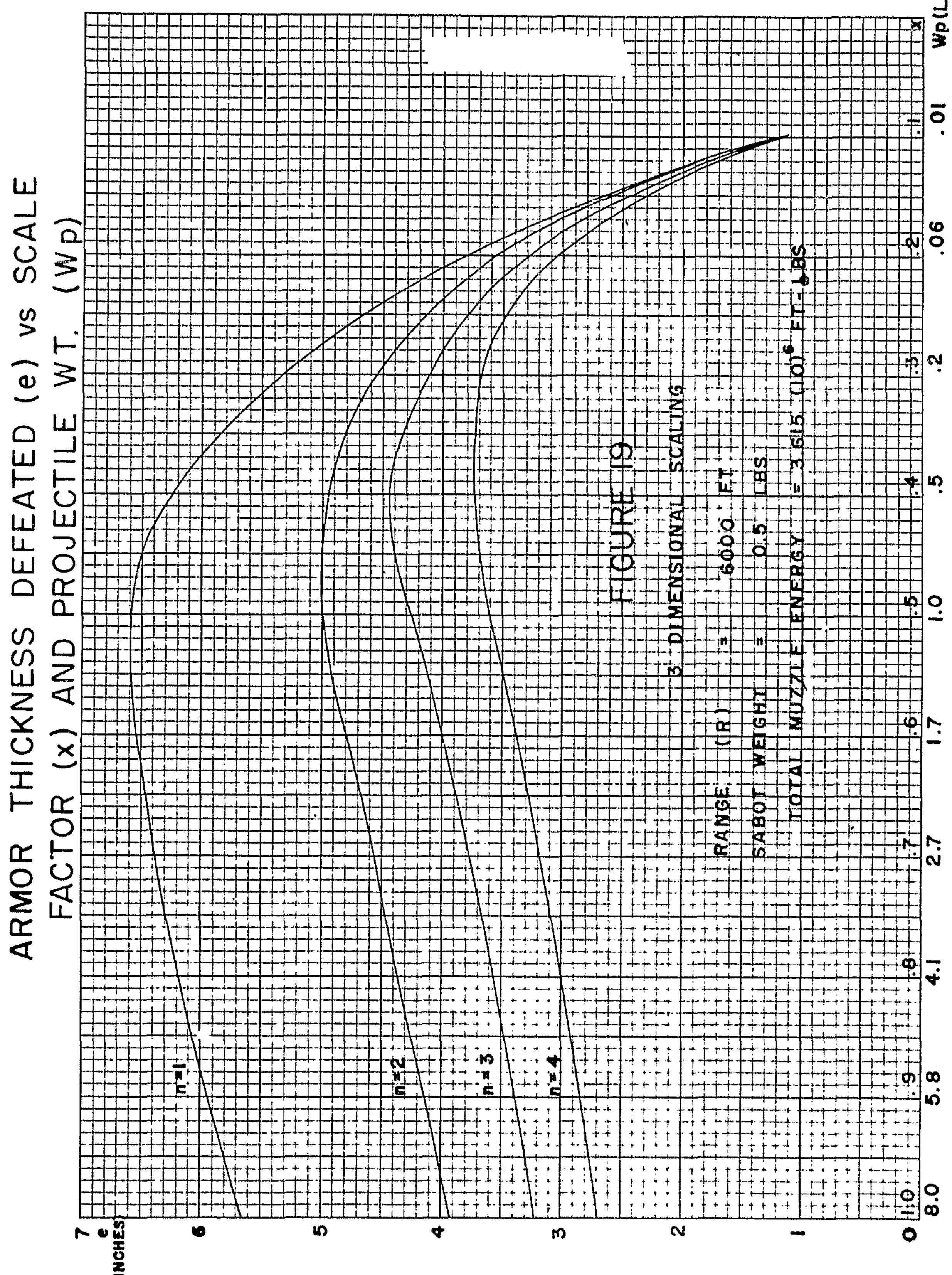




ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

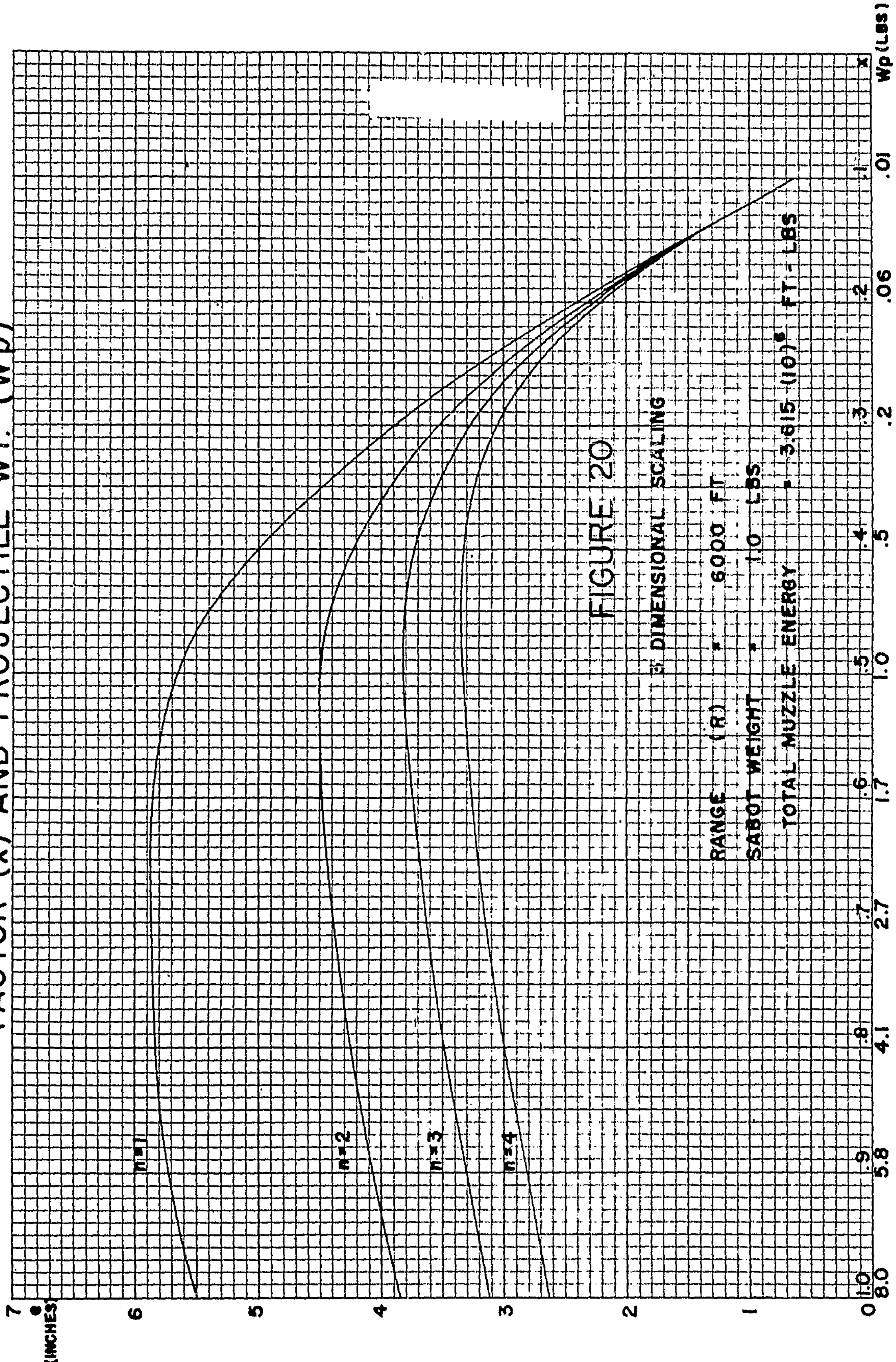
ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)





ARMOR THICKNESS DEFEATED (e) vs SCALE
FACTOR (x) AND PROJECTILE WT. (Wp)
FIGURE 19
3 DIMENSIONAL SCALING
RANGE (R) = 6000 FT
SABOT WEIGHT = 0.5 LBS
TOTAL MUZZLE ENERGY = 3.615 (10)^6 FT-LBS
n=1
n=2
n=3
n=4
e (INCHES)
7
6
5
4
3
2
1
0
x
Wp (LBS)
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
.01
.06
.2
.5
1.0
1.7
2.7
4.1
5.8
8.0

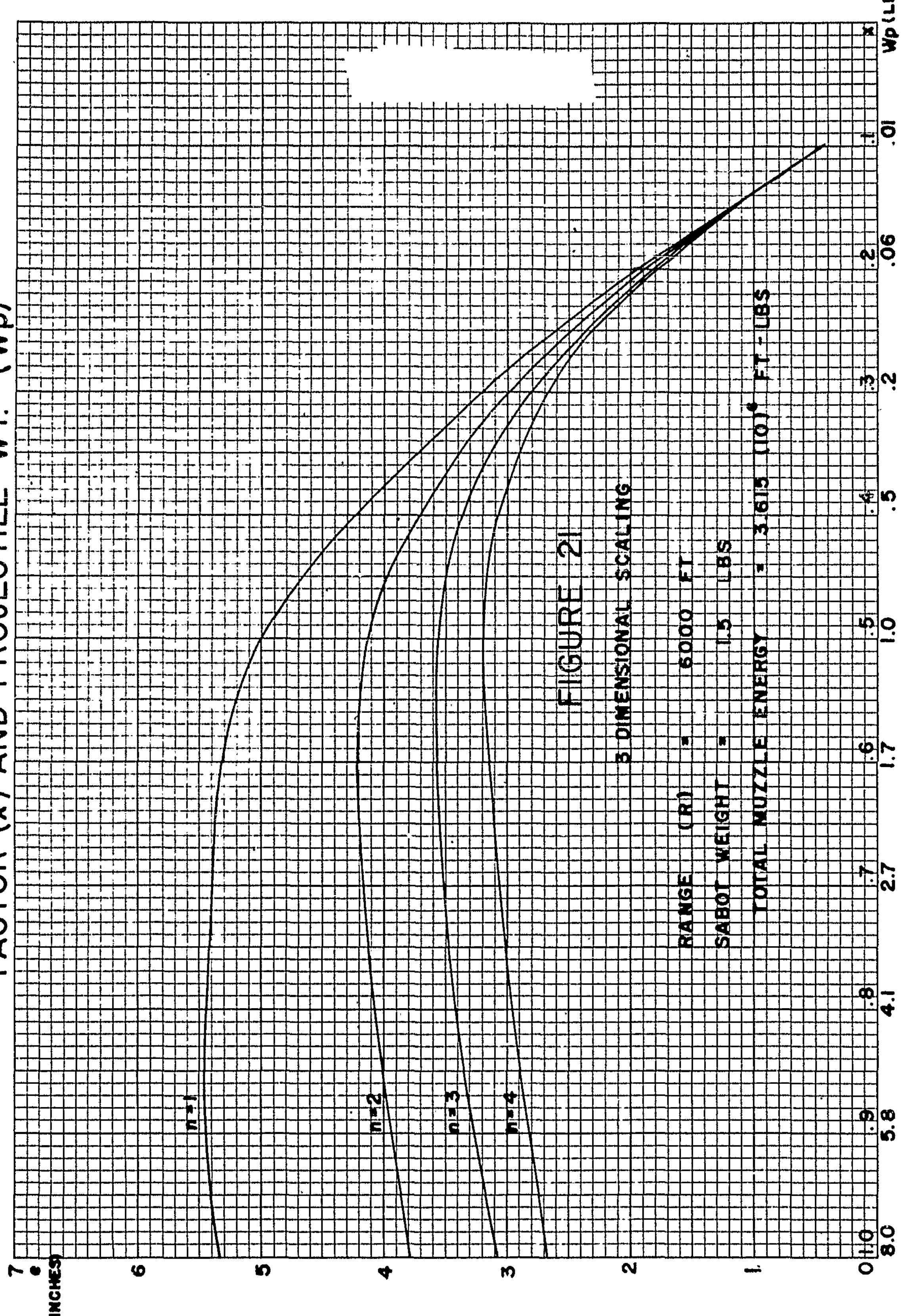
31



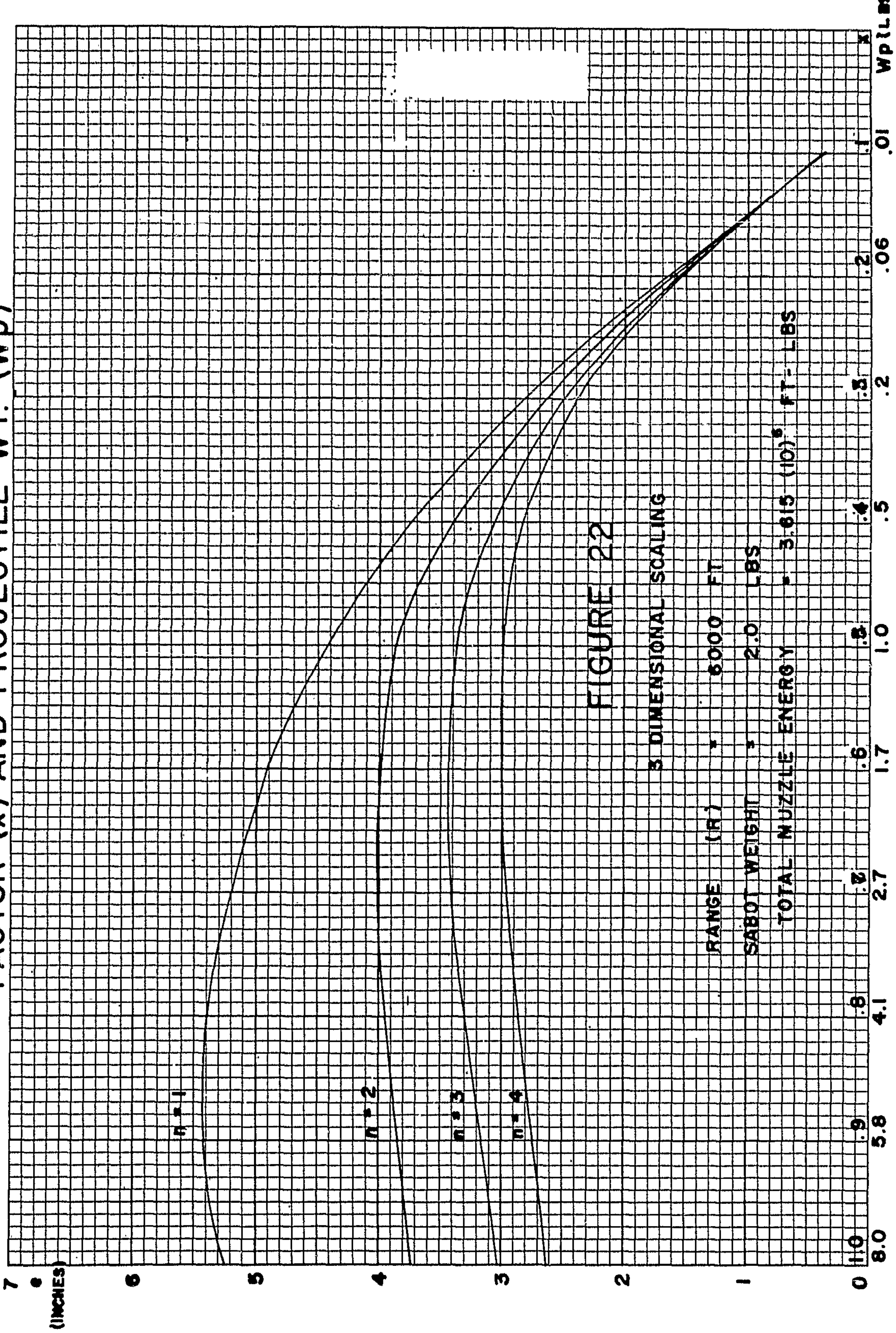
ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

FIGURE 20

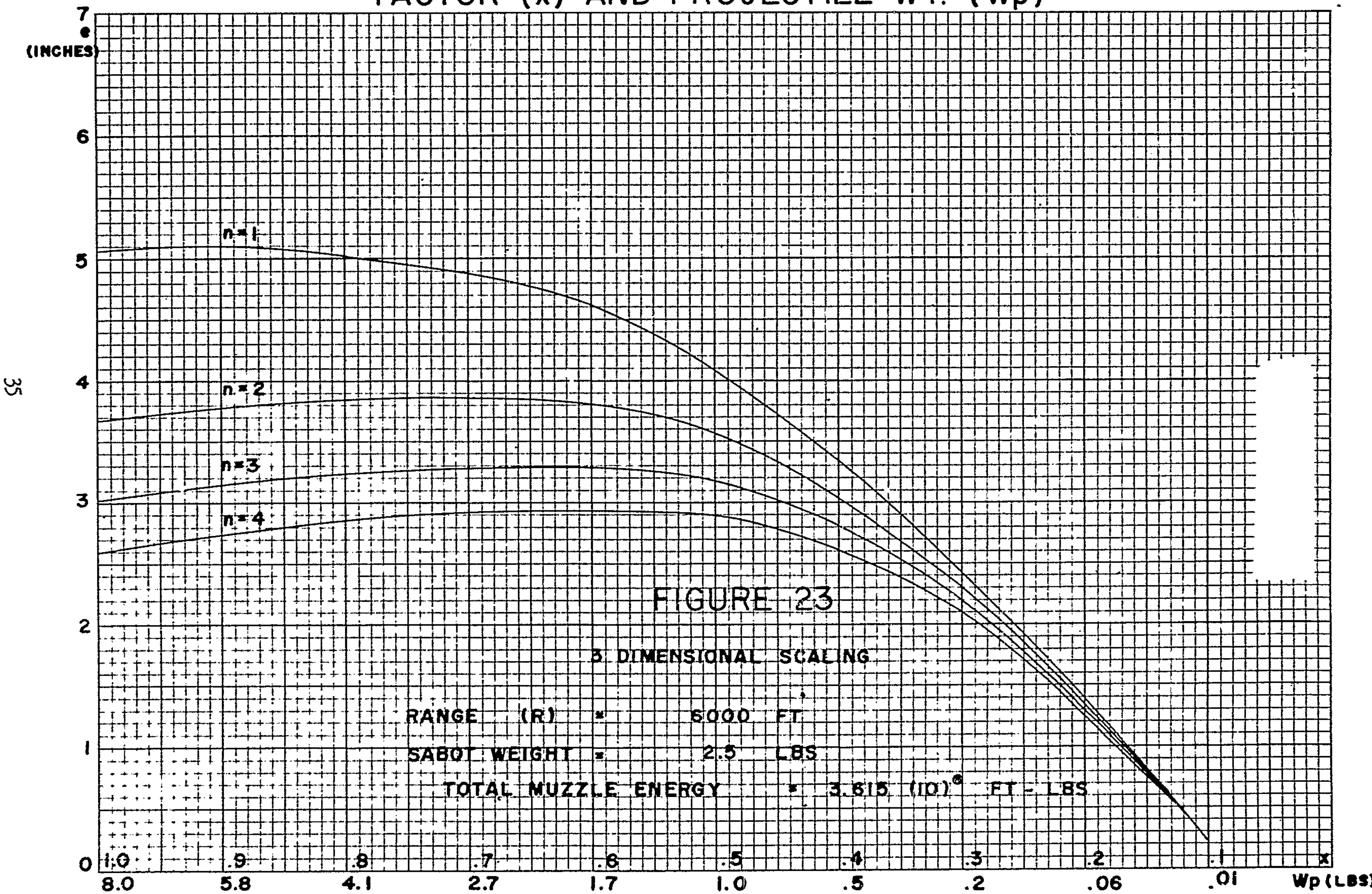
ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)

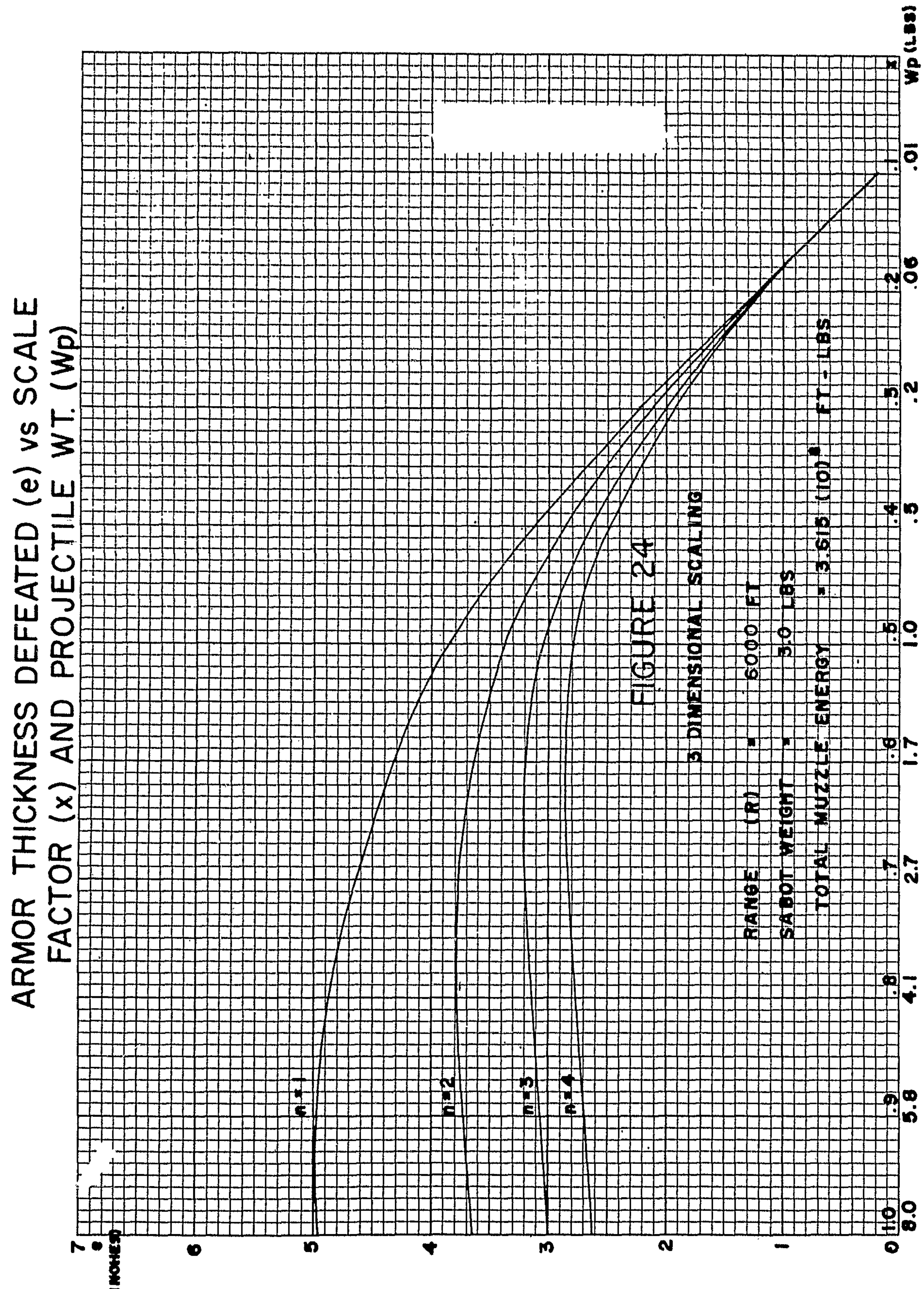


ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)



ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)




ARMOR THICKNESS DEFEATED (e) vs SCALE FACTOR (x) AND PROJECTILE WT. (Wp)
FIGURE 24
3 DIMENSIONAL SCALING
RANGE (R) = 6000 FT
SABOT WEIGHT = 3.0 LBS
TOTAL MUZZLE ENERGY = 3.615 (10)^8 FT - LBS
n=1
n=2
n=3
n=4
e (INCHES)
0
1
2
3
4
5
6
7
x
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
Wp (LBS)
.01
.06
.2
.5
1.0
1.7
2.7
4.1
5.8
8.0

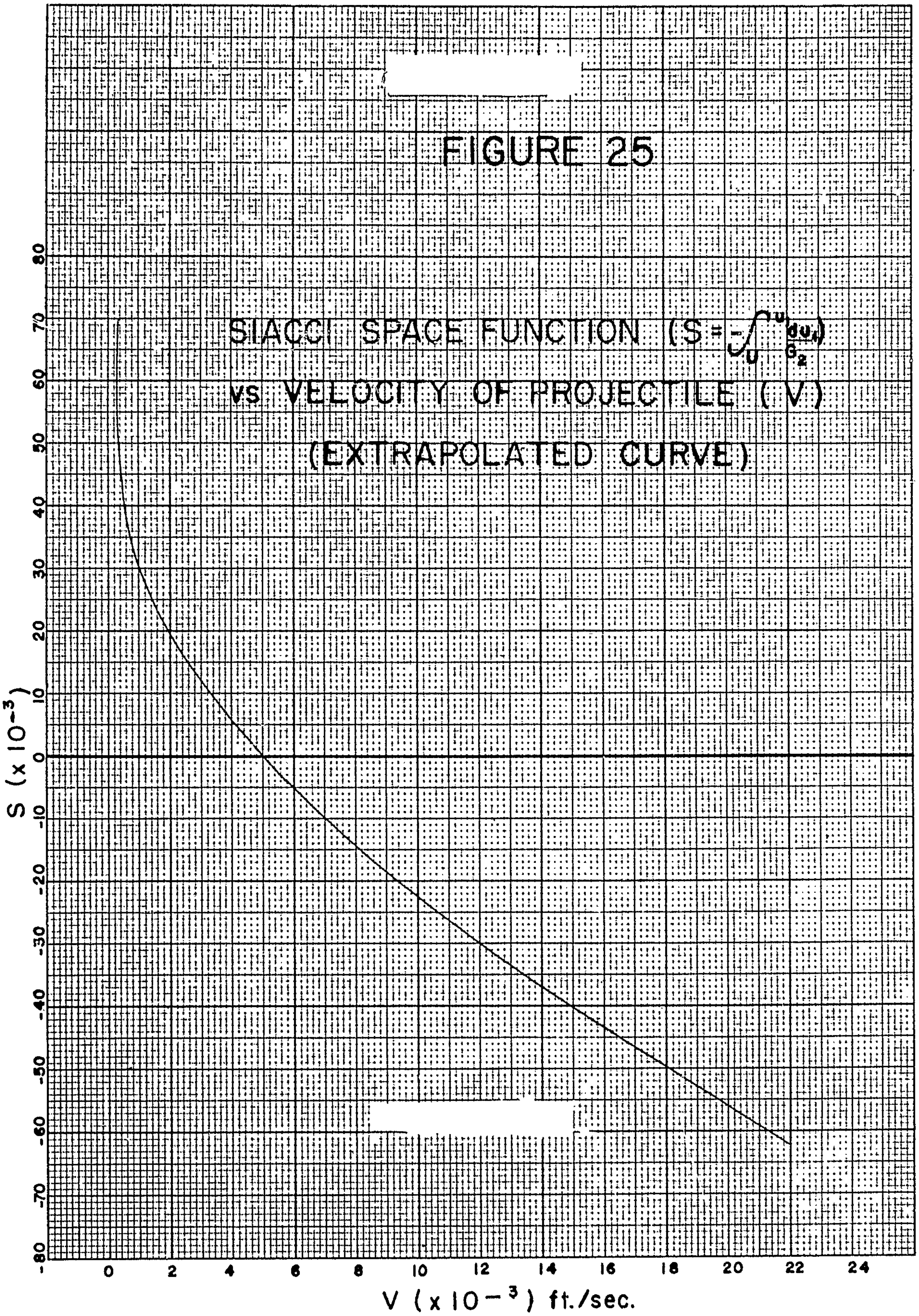


FIGURE 25
SIACCI SPACE FUNCTION ($S = -\int_{U}^{u} \frac{du}{G_2}$)
vs VELOCITY OF PROJECTILE (V)
(EXTRAPOLATED CURVE)
S (x 10^{-3})
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
2
4
6
8
10
12
14
16
18
20
22
24
V (x 10^{-3}) ft./sec.

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